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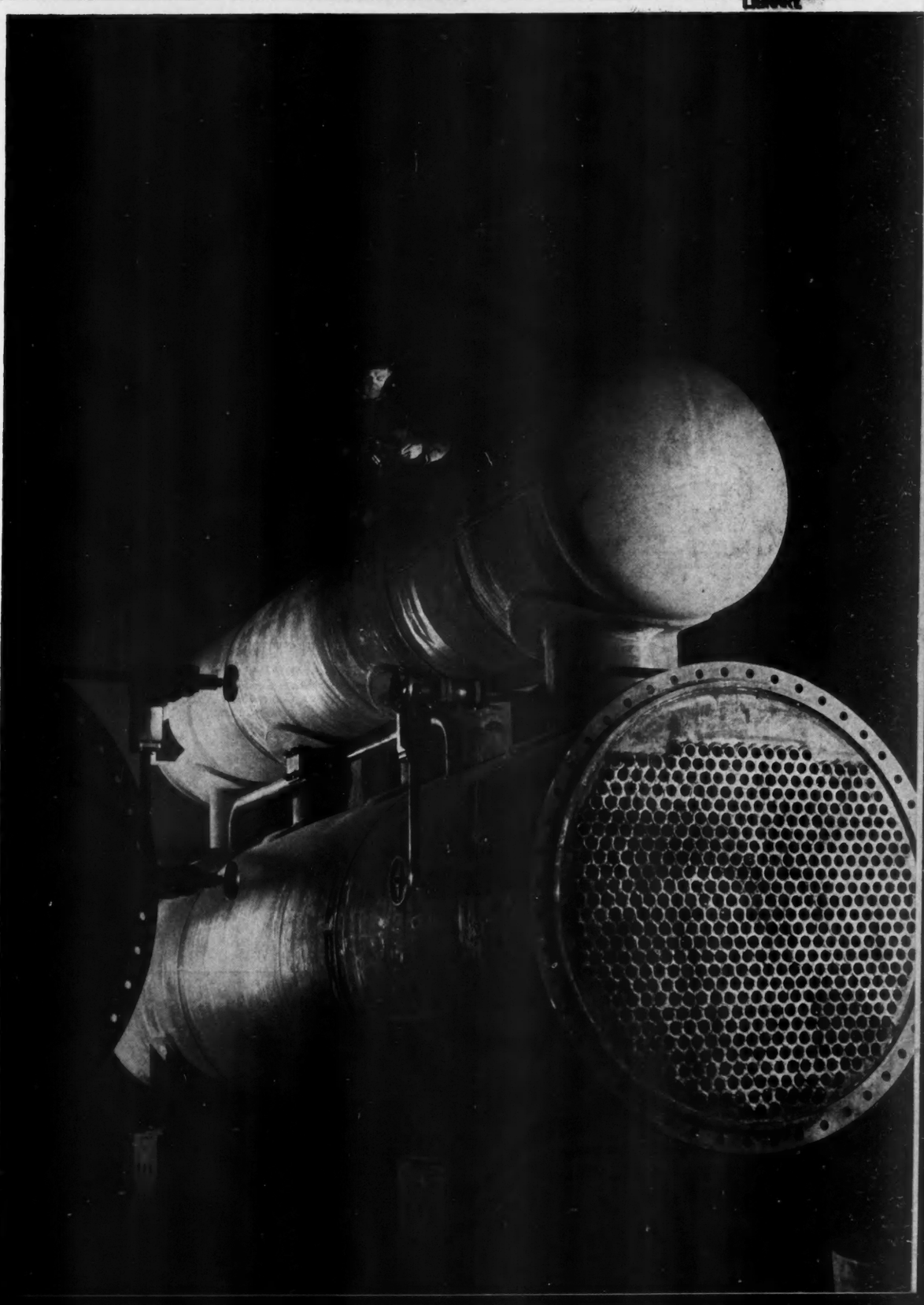

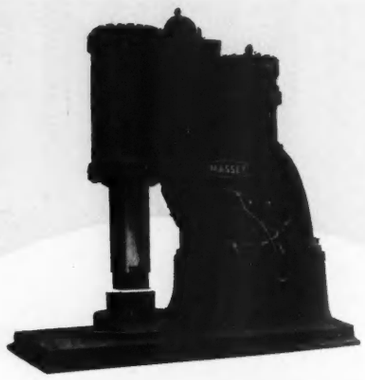

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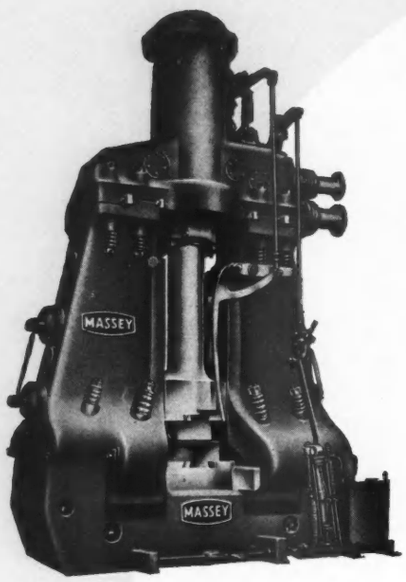

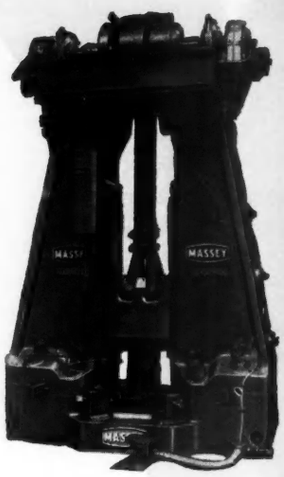

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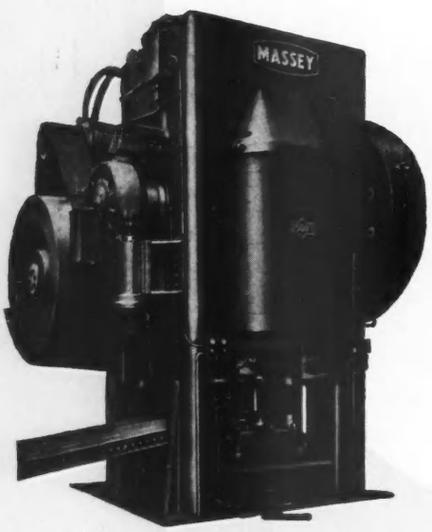

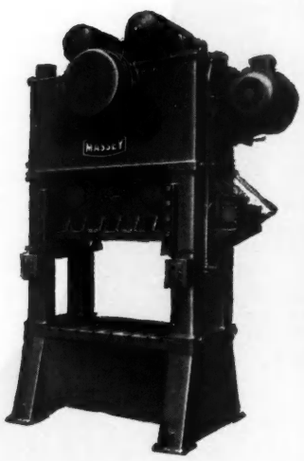

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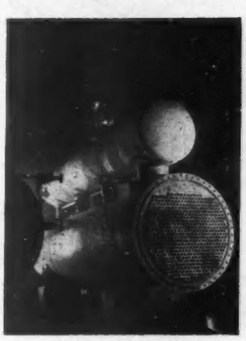

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The evaporator and condenser shown in the cover picture were fabricated as part of a contract for Russian plant.
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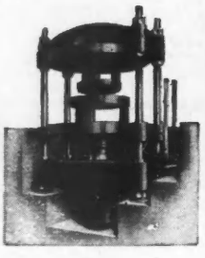

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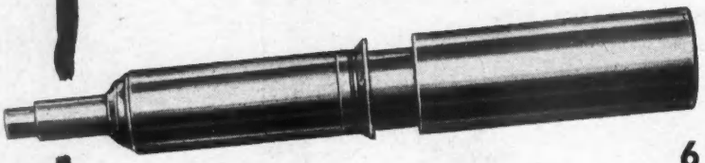

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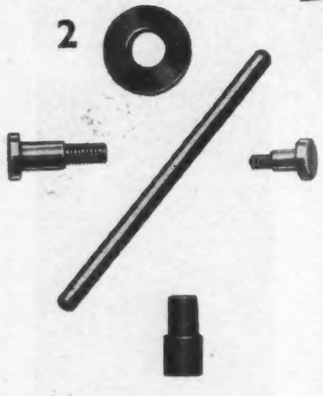

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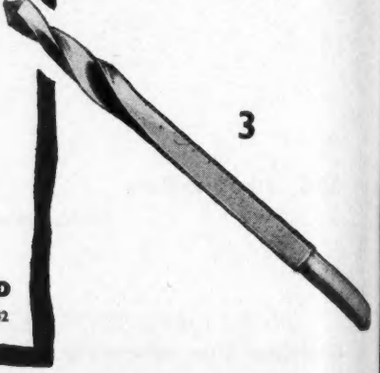

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ENGINEERING Impact

These Desirable Plots of Land

INDUSTRIAL development in Britain over the last fifteen years has been in two categories: one concentrated in the traditional areas of South Lancashire, South Wales and the North-East, and the other, more vitalized, in the "new" areas of the West Midlands, Greater London and the South-East. In these new areas the price of land has rocketed.

The post-war location of growing industries in the traditional areas has been to some extent due to the inherent geographical advantages of those areas. In addition, the policies of successive governments have encouraged new developments to go there because these areas, as well as possessing housing and urban facilities generally, have also been able to offer large pools of skilled industrial labour. For the new areas, where there was no previous industrial background, and where there have been no government inducements, it has been the basic economic advantages of the areas that have attracted industrial and commercial development. It is these areas that have been marked by a higher than average growth in population and employment. The prospect of improved communications—motorways, faster rail services and trunk dialling—have all tended to concentrate, not decentralize, development.

The rise in land prices was inevitable. It reveals an increasing demand to move into areas that are patently expanding and successful. It also represents the difference between the rents industry and commercial enterprises can afford and the cost of the developed land. Building costs have risen over the period, but they have not risen as fast as the earning capacity of industry, and the difference is the increase in land prices.

High-price land is well-developed land. In these expensive areas the better architects are flourishing; factories, roads and industrial plants are landscaped; engineering techniques are more advanced. In the unaffected areas, properties are neglected and drab, and industry is static.

Office Vacancies Filled by Machines

OFFICE mechanization has not universally kept pace with improvements in production efficiency. The lag has not been due to any lack of equipment.

The exhibition now open at Olympia gives managers the opportunity to examine a wide range of equipment. Selection of suitable machines and aids is a matter of great importance. The right equipment can effect large savings and lead to more harmonious working; the wrong may be a waste of money and, additionally, bad for morale.

A factor influencing the choice of equipment is the high cost of office accommodation in densely built-up areas. The output of some offices may be increased readily by installing new equipment, or even by using office furniture of up-to-date design, without providing extra floor area. The largest savings do not necessarily result from the more spectacular acquisitions. Equipment which can confer the maximum benefits is that which releases intelligent personnel for the performance of other work.

Consultation with the makers is advisable when selecting any kind of equipment, but it applies especially to business equipment. Failure to follow this practice can result in acquiring unsuitable machines or, worse still, a system which cannot produce the maximum benefits. Selection is simplified by the opportunity presented at Olympia of comparing the products and ideas of 154 firms under one roof.

Fundamentally, office machinery is like any other machinery: how much will costs be reduced for a given capital outlay? As with machine tools, the amount of time the equipment will be employed is a leading consideration in deciding whether it is a good investment. It is not every business that can benefit from the installation of a machine that is able to count 100 banknotes every 7 sec. And no firm would wish to repeat the experience of a company which recently agreed to pay £10,000 a year on office equipment for seven years, only to find, when the equipment had been installed, that it was too inflexible to meet all day-to-day needs. The tail wagged the dog.

of Becoming Temperature Conscious

DOMESTIC air conditioning equipment has recently—almost suddenly—become big business in Britain. The centrally-heated air-conditioned home has moved during the last few years from being regarded as the rather *outré* fashion of America to a desirable adjunct to any house. The degree, however, varies enormously, from a simple air heating and cooling unit to a full set-up with provision for automatic control of both temperature and humidity.

For many countries where extremes of temperature are commonplace, air conditioning is more than a luxury. But even in these cases, as for example in Aden, its adoption has been delayed. The development of packaged units, electrically operated, has promoted air conditioning in industrial countries, but in underdeveloped countries progress has had to wait on the provision of electricity supplies. Undoubtedly the great impetus has come from the sudden realization that man can control his environment and from the resultant demand that he should have a comfortable place in which to live and work.

From making units for tropical conditions, it is only a step to making simplified designs for the home market, where the demands are not so great. A large number of firms have put on the market units that can be built-in under the window to condition a single room but the growth of units to condition the whole house has not been nearly so rapid. Similar single-room units are being produced in quantity in Europe, showing that there, too, the demand for all-year-round comfort is being felt and the means brought within the financial reach of ordinary people. One example of a complete building installation is in the new Cooperative Insurance Society's block in Manchester (ENGNG., 22 Sept., '61, p. 379) in which the windows are not made to open at all (except for cleaning). Will houses one day be thus sealed off, with families living in a fully controlled environment?

of Choosing France for a New Factory

A NEW factory has been opened in France by C.A.V. Limited, of London, in a fifty-fifty partnership with a French company. Guests from Britain and France who attended the opening ceremony last week toured the factory to see the production of the C.A.V. diesel fuel injection pump type DPA (ENGNG., 7 July '61, p. 26). Sales of this distributor-type pump have been impressive since it was first made in England five years ago. There is now a demand for it in the Common Market, and the new factory is intended to meet this demand. Why was France chosen for the site in preference to West Germany, Italy, Switzerland or any of the smaller European countries?

C.A.V. had traditionally been strong in the Commonwealth; comparatively weak elsewhere. But the DPA pump was clearly a winner on its technical merits, well able to compete with anything Europe could produce—even in West Germany, where C.A.V.'s pre-war associates, Bosch, operate. In addition, some important users of C.A.V. pumps, including Perkins and Massey-Ferguson, were actively in the Common Market.

A survey carried out two years ago by C.A.V. to assess the possibility of a factory in Europe favoured France, partly because there was no massive competition there and partly because there was a suitable French company to join up with—the D.B.A. Group, who are the foremost automobile and aircraft accessory firm in France.

The new jointly owned company, Roto Diesel, have built their factory at Blois in the Loire Valley, to produce up to 8,000 units a month, though there is plenty of room for expansion. In England production is currently at the rate of well over 20,000 a month, or more than a quarter of a million a year.

France has turned out to be a fortunate choice for C.A.V. The French economy has made great progress in the past few years—industrial production increased by 11 per cent from 1959 to 1960—and the 4th Modernization and Equipment Plan, to be announced by the Government this autumn, is expected to fix bold expansion targets for 1962-1965.

The Bulge

SO far, the more fearful apprehensions about the ability of industry and other employers to absorb the "bulge years" school leavers have not been realized. This year there were approximately 40,000 more leavers than last year, yet the unemployment figures for boys and girls are roughly comparable.

From mid-July to mid-August, the number of registered unemployed in the under-18 age group rose by 27,000 to just over 32,000, a figure which, in fact, was lower than at the same time last year. This is not considered to be a frighteningly large figure because many school leavers wait until after their own or their prospective employers' holiday before taking up a job.

However, it is difficult to know how much importance to attach to figures for registered unemployed because many people in this age group looking for their first job do not register themselves before seeing the particular vacancy that interests them. Indeed, over 64,000 boys and girls in this age group (double the official unemployed figure) moved into new jobs between mid-August and mid-September though, of course, some of these would have moved from job to job rather than from unemployment to employment.

By and large, the special problems of the bulge have not yet become insoluble. But there are three reasons why one cannot be complacent about the position, namely, (*a*) it now appears that the bulge is not a short-term problem; (*b*) more young people seem to be travelling greater distances to work, a factor which is bad socially and from the point of view of industrial efficiency; and (*c*) the vast proportion of teenage unemployed are unqualified and unskilled, suggesting that the essential cumulative problem could become one of insufficient training facilities rather than of sheer unemployment.

Mechanization of Conventional Armies

WHAT is the overall effect of nuclear warfare, and the publicity it generates, on the decisions made by the Army when considering equipment requirements for the future?

Why spend huge sums of the taxpayer's money on supplying what appears to be out-dated, conventional equipment to the armed forces? Even if men are able to avoid worldwide conflict, for the present at least, they are still prone to skirmishes of a lesser nature, and it is here that the foot soldier and his associated equipment and vehicles will continue to play a vital role.

Since the Second World War, there has been a gradual change in the technique of land warfare as new weapons have been developed. This change has not been so marked on land as it has been in the air, where methods of combat have changed beyond all recognition with the advent of the jet engine. Previously armour plate held the ascendancy and the heavier vehicles have had the best chance of survival. Now weapons have been evolved enabling one infantry man to destroy the heaviest known armoured vehicles. The tank has had a good run, but if victory on the battlefield is to become a triumph of mind over matter there will no longer be a place for it, and the army will shed its armour as did the foot soldier when the introduction of firearms rendered it useless.

The bomber is no longer armed, relying for defence on its speed and ability to fly either very high or low depending on the circumstances and the type of attack for which it has been designed. This has greatly increased the scope of the design team, who had hitherto done no more than provide a means of counterfire. This tendency towards shifting the responsibility from the participant to the brains behind the machinery is spreading throughout the services. Soon the heroes will not be found on the battlefields but on the drawing board.

Perfection in Engine Air Cleaning

Of the breakdowns of earth-moving equipment 90 per cent are said to be due to dust. The quest for a perfect engine air cleaner has resulted in a mechanism which meets all points of a rigorous specification.

A good deal of controversy exists regarding the most harmful sizes of dust particles in relation to engine wear, but evidence has shown that maximum wear occurs within the range of sizes from 1 to 15 microns.

If a sufficient quantity of dust is present under 5 micron size considerable wear will occur as these particles are usually passed through most commercial air cleaners.

Whilst all types of vehicles suffer equally, earthmoving and roadmaking plant invariably sustain greater damage because they work in dust clouds of their own creation. Tests have disclosed that improvement in air cleaner efficiency was a necessity for Service plant.

The Military Engineering Experimental Establishment (MEXE) at Christchurch, Hants, undertook a study and Lt.-Col. G. L. Coates of MEXE gave details of this in a paper entitled "The Search for the Perfect Engine Air Cleaner" to this year's meeting of the Society of Automotive Engineers.

Specification

It was agreed that the following target should be aimed at:—

(1) The air cleaner must prevent all particles of dust of 1 micron or larger entering the combustion chamber of the engine.

(2) It must offer equal or less engine strangulation than existing commercial air cleaners in the new condition.

(3) No build up of engine strangulation must occur during the life of the air cleaner.

(4) Operation must be equally satisfactory in extremely dusty conditions alternating with maximum humidity conditions (monsoonal).

(5) The air cleaner must not require any servicing or periodic attention for at least 1,000 hours after installation.

(6) It must be competitive in initial cost.

(7) It must be inexpensive in running costs.

(8) It must be capable of ready mounting on earthmoving and roadmaking plant.

H. J. H. King and Company Limited, of Nailsworth, Gloucestershire, who manufacture large size air cleaning plant (not automotive) was approached to produce a prototype for use with a 150 bhp 4 stroke engine. A suitable test cell was constructed to enable an evaluation to be made in accordance to SAE and BSI standards for testing of air cleaners.

To prove the adequacy of the cleaner in accordance with item (1) of the above specification, i.e. removal of particles of 1 micron dust, the whole throughput had to pass through an absolute filter of adequate dimensions capable of arresting any dust getting through the filter. This absolute filter consisted of a filter chamber containing three separate sheets of No. 40 quality Whatman filter paper through which the air from the air cleaner had to pass. The manufacturers of the paper gave an assurance that no dust larger than 1 micron diameter would pass through. One side of the filter chamber was connected to the air cleaner under test and the other to the input side of a 500 to 600 cu. ft per min centrifugal fan.

The air cleaner testing cycle consisted of 200 hours running in a maximum dry dusty atmosphere followed by 100 hours running in a steam laden atmosphere, thus simulating the conditions prevailing before and after the monsoon occurs in tropical and semi-tropical countries. The total test time was not less than 1,000 hours under these conditions.

Several types of cleaning mechanism were produced and most of the earlier models, though effective, were complicated and inclined to be costly even in mass production. Eventually a much simpler, less expensive and more reliable mechanism comprising fewer parts and capable of inexpensive mass production was produced. The entire cleaning mechanism for engines of up to 500 bhp could be held in the palm of the hand. (See Fig. 1)

The manifold filter cleaned itself every 4 min by discharging an air bottle of approximately ½ cu. ft of air at 80 lb per sq. in through each of the four filter elements in turn in a reverse direction at 1 min intervals. The effect of the sudden blast of air from inside to outside of the filter element wall released the dust which had accumulated on the external wall so that it fell clear of the filter into the open atmosphere.

Operation

The ½ cu. ft air bottle previously mentioned is coupled to a small compressor which is usually to be found on earthmoving and roadmaking plant for either power assisted steering, braking or tyre inflation. These are capable of charging at about 100 lb per sq. in. A small restrictor is included in the compressor-to-bottle air line which acts as a timing device causing a valve in the cleaning mechanism to operate when 80 lb per sq. in is built up in the small air bottle which is directly coupled to the cleaning mechanism.

Air is introduced at the connection marked "air" on Fig. 2 and when an operating pressure of 80 lb per sq. in is reached in the air bottle, it moves the piston off its seating, allowing the air to pass along grooves machined in the wall of the piston and through an uncovered hole in the face of the ratchet wheel to the inside of filter element No. 1.

Immediately the piston moves off its seating it presents a far larger operating area to the incoming air which moves it smartly to the extreme limit of its stroke, compressing a valve spring in so doing and moving a pawl forward over one tooth of the ratchet. Having expended the bottle full of compressed air through the filter element, the spring restores the piston to its seat and the piston rod rotates the ratchet wheel one tooth and uncovers the port leading to the inside of filter No. 2 element.

A similar action is repeated and No. 2, 3 and 4 elements are cleaned.

The cleaning cycle is controlled by the time taken to charge the blast bottle to 80 lb per sq. in and this is the function of the restrictor in the compressor-to-air-bottle airline. Running a mechanism on an 8 sec cycle, MEXE have accomplished the equivalent of 35,270 hours of operation and the elements have been cleaned 728,440 times. This unit is being run to destruction or until breakage or failure occurs.

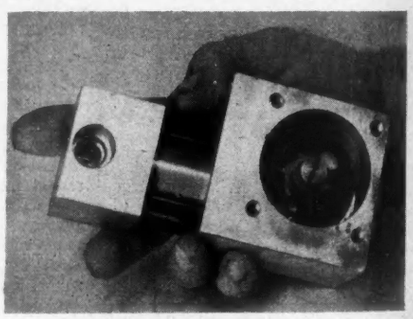


Fig. 1 (right) The entire cleaning mechanism for engines up to 500 bhp can be held in the palm of the hand.

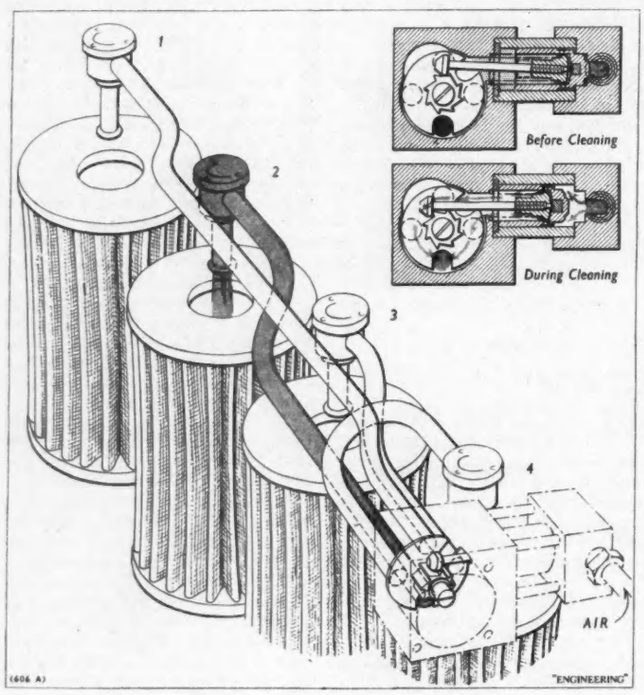


Fig. 2 (left) This shows No. 2 element being cleaned; action for Nos. 1, 3 and 4 is exactly similar. It will be seen that another port has been uncovered on the opposite side of the ratchet wheel and air has passed down the air line from this port to No. 2 filter element. Immediately the air bottle has discharged its contents through No. 2 filter element, the valve spring restores the piston to its seating and pulls the piston rod back one tooth leaving the port to No. 3 element uncovered and ready for cleaning.

The actual elements themselves are pleated, mesh encased felts, each having approximately 14·4 sq. ft of filtration area, and each element is located in a separate support tray mounted within the outer case.

The air cleaner has been subjected to a continuous test for 1,088 hours in an artificially created dust storm of far greater dust density than would normally be encountered. In addition a tractor at MEXE fitted with such an air cleaner has run for over 3,000 hours and the engine has never had the cylinder head removed; the usual figure between overhauls is nearer 1,000 hours.

It was felt at MEXE that the effort to produce the engine manufacturers' idea of a perfect air cleaner had reached a fair degree of success as their model has measured up to all the requirements laid down in the original specification.

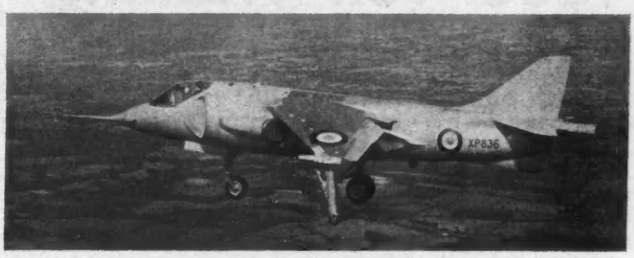
It is understood that the design is to be put into production in this country with a view to selling to civilian commercial users.

Successful Flight Transitions by the Hawker P1127

It was last March that the Hawker P 1127 VTOL strike aircraft first made its conventional take-off. Previous to this it had made tethered flights and then hovering trials without any form of ground restraint.

It was recently annnounced that the aircraft has carried out successful transitions from vertical to horizontal flight and vice versa at Hawker Aircraft's airfield at Dunsfold. This phase of the flight testing is in some ways the most critical and it represents an important milestone in the application of the "vectored thrust" principle to engines designed for vertical take-off.

Bristol Siddeley, whose Pegasus engine powers the P 1127, believe that the total installed thrust of a VTOL aircraft's main power-plant must be available for vertical take-off and landing, and hovering in addition to forward flight. This is accomplished with the Pegasus by the use of four controllable jet nozzles which are directed downwards for lift, and when the aircraft has climbed vertically to a suitable altitude they are gradually rotated backwards so as to give the aircraft forward acceleration.



The P 1127 has recently made transition trials from horizontal to vertical flight and vice versa.

When flying speed has been reached, the nozzles face directly backwards so that the whole thrust of the engine is available for forward propulsion.

This is the meaning of "vectored thrust" as opposed to the combination of vertical and horizontal thrust provided by the separate engine system. It is claimed that this system not only allows all the installed power to be used for take-off but brings simplicity to design and maintenance by the use of a single engine. Ground erosion problems associated with fixed lift engines are avoided, because taxying and running over the ground can be done with the nozzles facing backwards.

The P 1127 is intended to be the world's first military VTOL weapons system and not merely a research vehicle. From its inception the design incorporated military systems and weapons as well as the fuel capacity to give worthwhile operational ranges. The aircraft has attracted considerable technical attention and, in addition to RAF interest, the possibility of its adoption by NATO as the standard lightweight strike fighter has been considered.

Curing Teething Troubles of Diesel Locomotives

For a plan which is as large and takes as long to mature as that for modernizing British Railways it is difficult to compare facts and figures regarding one form of traction with another.

In his presidential address to the Institution of Locomotive Engineers, Mr. J. F. Harrison, chief mechanical engineer of the BTC Railways Division, said that by careful sifting of the facts and segregating performance into similar pockets, the following picture is found to be developing.

For comparable duties, steam locomotives performing express passenger work are averaging 170 miles per calendar day with an average casualty rate of 1 per 17,000 miles, whereas working similar express passenger services, diesel locomotives of comparable power are averaging 300 miles per day with a casualty rate varying according to the Region between 1 per 12,000 and 1 per 22,000 miles.

One of the main sources of failure with diesel locomotives has been in the steam heating apparatus. Such a large proportion of the casualties have come from this cause that if the figures mentioned above were adjusted to eliminate steam heating failures, then the diesel locomotives would be averaging a varying casualty rate of 1 per 15,000 to 1 per 26,500 miles.

The standard Type 1 diesel locomotives which are not fitted with steam heating boilers, employed on freight transfer and shunting duties, are averaging a casualty rate similar to steam, something like 1 per 70,000 miles or 1 casualty per locomotive every 2½ to 3 years.

Mr. Harrison observed that the present casualty rates are not good, but that each month they show an improvement as teething troubles are eliminated.

Apart from steam heating boiler failures, the other teething troubles divide into three groups: (*a*) control gear, (*b*) engine equipment, such as blowers and pipes, and (*c*) miscellaneous.

It was originally felt that the engines themselves would be the most likely source of trouble along with transmissions and pipes. However, the engines have been pleasantly free from trouble, though they have all "suffered initially from some curable 'digestive' difficulty." Electrical transmissions have in general given satisfactory performance. Mr. Harrison said that what troubles there had been were, in his view, due to manufacturing deficiencies rather than design.

With some engines, one constant source of trouble has been with superchargers and, in another field, it is only now that control gear is being produced in a satisfactory and robust manner. Regarding the steam heating generators, which had been giving endless trouble because of all their numerous components necessary to provide automatic control to fuel and water, Mr. Harrison said that steps taken by manufacturers to improve the standard of equipment, and by British Railways to ensure adherence to a rigid schedule of maintenance, have shown a most encouraging improvement.

The Unimog: An All-Purpose Tractor

Having a well-proven design of 10 years standing on the Continent during which time it has seen service with NATO forces, the Mercedes-Benz Unimog all-purpose tractor is now available in Britain.

Possessing an appearance more like that of a cross-country vehicle than the recognized configuration of an orthodox tractor, the Unimog is based on a sturdy chassis upon which are mounted live axles driven through lockable differentials from a centrally positioned 6-speed forward/reverse synchromesh gearbox. The front-mounted engine is a conventional four-cylinder diesel developing 35 bhp at 2,550 rpm, and is basically the same as that used in the 180D saloon car.

Suspension is by coil springs and telescopic dampers. The axles incorporate hub reduction by spur gears which facilitates an unusually good ground clearance of 18 in under the axles. Clever design in the positioning of the centre of gravity has prevented this from contributing to instability and the tipping angle is 38°.

The lorry-type configuration possesses advantages over the normal tractor in the all-weather driving cab, available in either convertible or fixed trim, and the load platform (approximately 23½ sq. ft) which allows the vehicle to carry equipment and/or personnel far from base without the necessity for towing a trailer.

Power for the attachments is provided by three PTO shafts: front and rear, for use with a variety of pumps, compressors, winch gear and a whole range of rear mounted agricultural implements. Certain harvesting equipment such as that used for sugar beet may be driven from the third at the side.

Being light and economical to run and yet capable of applying a high tractive effort (up to 60 tons gross train weight is claimed) the Unimog should prove particularly attractive to the lumber man for whom it would possess many advantages. The gearbox gives a speed range at maximum power of between 2·2 mph and 33·0 mph. An optional auxiliary crawler gearbox of two ratios reduces the lowest speed to 0·7 mph.

Nearly all the optional equipment has been designed and built around the Unimog by German specialist manufacturers who have taken advantage of convenient mounting facilities provided by the chassis and the availability of

The Unimog is an all-purpose tractor of 35 bhp with a top speed of 33 mph. It is claimed that it can haul a 60 ton train.

pneumatics front and rear. These include in addition to the usual agricultural and excavation plant, less commonly used items such as a ground auger, a drilling derrick for a 200 ft depth and a range of snow clearance equipment. *Mercedes-Benz (Great Britain) Limited, Great West Road, Brentford, Middlesex.*

1800 Ton Walking Dragline for the NCB

Just beginning operations on a National Coal Board open-cast site in South Wales is what is claimed to be Europe's largest walking dragline.

READERS of present day technical magazines must inevitably become insulated to the many superlative claims that are hurled at them regarding engineering products. This article describes a new walking dragline which because of its size and what it can do offers no relief to this trend. It is an impressive machine, developed from the original Rapier W1400 supplied to Stewarts and Lloyds in 1951.

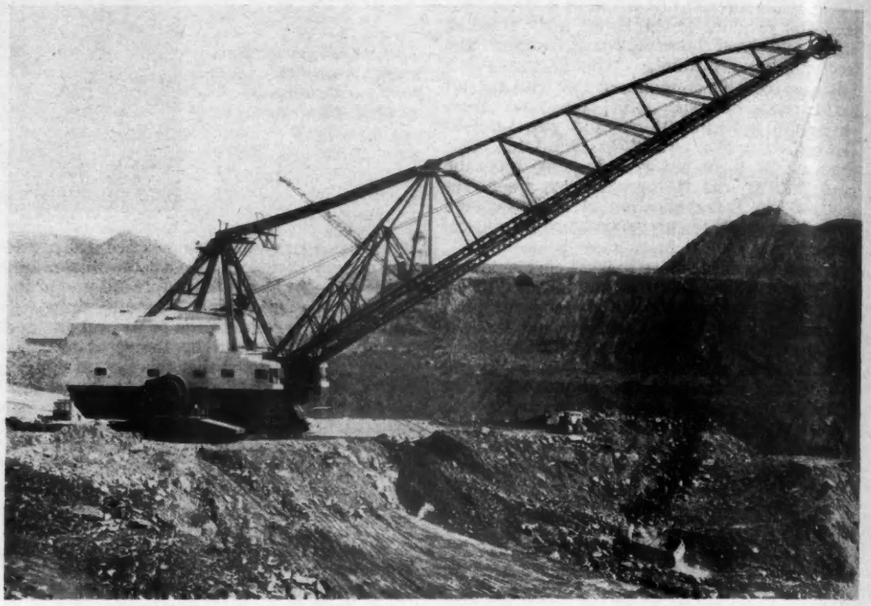
Costing more than £900,000, this machine is said to be the largest in operation in Europe and is to be used by the National Coal Board in the open-cast coal workings at Maesgwyn Cap, Glyn Neath, South Wales. It is known as W1800, weighs 1,800 tons and was made by Ransomes and Rapier. Operation of the machine will be in the hands of George Wimpey and Company Limited on a contract which involves stripping the overburden to a depth of 300 ft to expose and recover best quality anthracite.

The boom, which is of lattice and girder work construction in HTS steel, is said to be the biggest ever made in this country. Made by Newton Chambers, its basic length is 208 ft but there are two extensions which permit two operating lengths—282 ft with a 30 cu. yd bucket and 247 ft with a 40 cu. yd bucket. The larger bucket weighs 33 tons and takes 60 ton bites at the overburden.

The reach of the boom is important. The radius of discharge (vertical) with the longer boom is 260 ft and with the shorter 230 ft. Maximum allowable working loads are 65 and 91 tons and dump heights are 130 and 100 ft respectively. Being of the cantilever type, the boom is suspended in its operating position by means of a structural steel suspension member connecting the apex of the boom to the gantry head. Derrick ropes and derricking gear are provided only for raising and lowering the boom and do not carry any load during the normal operation of the machine.

While digging, the W1800 sits on its circular base which has an area of 2,380 sq. ft and when it is required to move, it does so through the operation of a walking mechanism. On each side there is a giant rectangular walking shoe attached to a leg structure. The walking operation is done by placing the shoes on the ground and lifting the entire machine forward by means of the eccentric bearing on which each leg is mounted. Walking strides measure 7 ft 7 in.

The base structure is 55 ft dia and is built up of rolled steel plates and sections which give the necessary strength and rigidity for digging and walking duties.



Said to be the largest walking dragline in Europe, this W1800 made by Ransomes and Rapier weighs 1,800 tons and can take 60 ton bites at the overburden of this South Wales open-cast coalmine.

The rotating frame, 94 ft long by 69 ft wide, is fabricated from rolled steel plates to form four full length longitudinal girders 14 ft deep for carrying the roller path which is made of special nickel chrome molybdenum cast steel segments of bridge type rail section. The roller circle consists of a 48 ft dia live ring made up of 125 alloy-steel taper-rollers mounted in a structural frame.

The entire machine is designed with a view to easy handling and speedy operation and is entirely electrically driven with Ward-Leonard Amplidyne control. There are eight 300 hp motors, four of them for hoist and four for drag. In addition there are four 225 hp "walk" motors and four more of the same horsepower for "swing."

The machinery house has a crane gantry on which runs an electric overhead crane with two 10 ton crabs. These are for maintenance purposes and can handle any of the machinery.

One driver is in sole control of the W1800 while digging and walking. He works from either one of the two glass fronted cabins on each side of the superstructure. Which one he uses is determined according to the view he prefers as he is slewing the giant boom one way or another. The control console in each cabin is identical and each contains master controllers for the hoist, drag/swing and walk motors as well as the necessary control switches for the operation of the excavator. Windscreen wipers keep visibility clear and cabin heaters are provided for driver comfort.

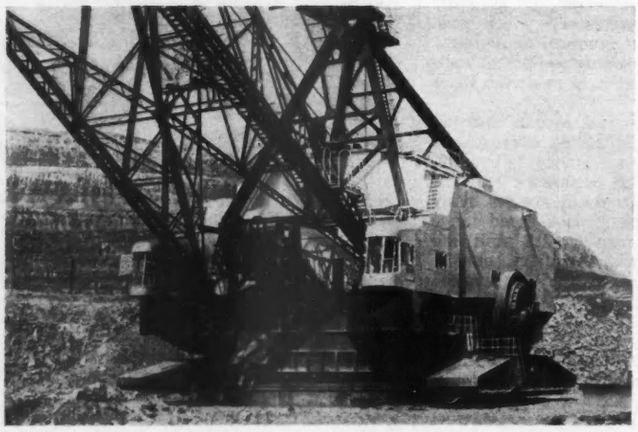
Between the two cabins a gallery extends around the front circular girder of the superstructure and from this gallery a clear uninterrupted view of all the digging and hoisting operations can be obtained.

A welding set operating on 440 volts 3-phase supply and capable of 200 amps continuous and 300 amps intermittent is provided for maintenance and for emergency repairs.

Erection of the W1800 was carried out by the outside erection department of Newton Chambers and Company. Some 40 men were employed and the work took over one year.

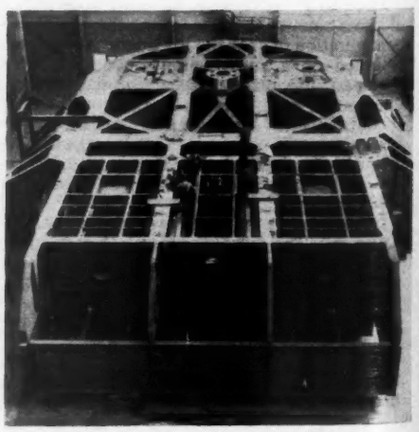
Another W1800 is nearing the final erection stages near Scunthorpe for the United Steel Companies Limited and yet another is being built for Stewarts and Lloyds.

Ransomes and Rapier Limited, Waterside Works, Ipswich, Suffolk.
Newton, Chambers and Company Limited, Thorncliffe, Sheffield.



(Left) The giant walking shoes can be seen on each side of the superstructure. Walking strides measure 7 ft 7 in.

(Right) The revolving frame seen inverted. It measures 94 ft long by 69 ft wide and is 14 ft deep.



Plain Words

By Capricorn

IT is difficult to project one's mind forty years on from 1961, to the industry of Utopia to which we are all striving, but I will try. I will take, as a reasonable expression of our aims, the statement recently made by Mr. Hugh A. Warren: "Each example of a human skill still used in industry is a challenge to the engineer and the economist to use their technology and finance to replace it by more productive methods."

At an engineering works in the vast Automation Industrial Estate in the Midlands, the Chief Inspector of Factories is making his annual tour. When he joined the Ministry of Labour as a young man in 1961, the main interest of his department was in the reduction of accidents by improved fencing of machinery, but now industrial accidents are almost unknown as hardly anyone actually works with his hands. Indeed, one of the purposes of his annual visit is to check on this point. "There's a man over there, Mr. Smith, using his hands. Please see if you can eliminate that by next year."

While this inspection is taking place the Liberal Assembly is meeting in Edinburgh. A young, ardent Liberal is holding the attention of the delegates. "Fellow Liberals," he says, "forty years ago, in 1961, and in this great city, Jo Grimond called on our party to see that workers in industry were brought on to the boards of companies. 'I want to get to the stage,' he insisted, 'where the workers in British industry genuinely feel that they employ the managers and are consulted at every stage of the industrial process.' My friends, those were courageous words in 1961."

The Liberal delegates listen attentively as he continues: "You all know that management has been revolutionized in the past forty years. The intuitive decision-making which used to send managers to an early grave has been eliminated. Our manager-computers solve all those problems which were formerly a brake on progress. We have reached the stage where our worker-directors are becoming bored. Their minds are not stretched. What is to be done? I will tell you. Recent studies at the Research Establishment for the Development of Human Ability Potential (REDHAP) have shown that human hands, properly trained and directed, are capable of the most amazing feats. The subjects for these exciting experiments were concert pianists—the only men and women who have perpetuated the manual skill of former times.

"Fellow Liberals: I ask you to call on the Government to implement the results of this striking research without delay. Only then shall we raise productivity, restore happiness and pride to our working population, and compete effectively in export markets by employing skills which are denied to less fortunate countries."

Hear, hear.

Letters to the Editor

Grand Prix Formulae

SIR, You published a letter recently (ENGNG., 15 Sept. '61, p. 333) from my friend and rival of 1957-58-59, John Wyer of Aston Martin Lagonda Limited, taking me to task for one or two points from my article "Brighten Racing With Larger Engines" (ENGNG., 25 Aug. '61, p. 231).

I did, of course, specifically state that attendances in this country (not abroad) were falling, and would not argue that one of the reasons for this is that there are a large number of races being held in Britain at present. This surely is all the more reason to present an additional colourful and spectacular formula. Motor racing may then attract the larger "gates" that are desired.

I believe John Wyer would agree that the best way to discover and train drivers is to give them plenty of motor racing. This is, of course, why we and the Americans have the large number of expert drivers at present, and why Continental countries have a considerable shortage.

I did not suggest in the article that Formula Senior cars should replace Formula 1 cars. The present Formula 1 must run for its allotted time. Formula Senior would replace the vacuum left by the sports racing cars and Formula II cars, and also, of course, the Inter-Continental cars. I do not believe that either Grand Touring or Formula Junior racing can do this, except the former class in the long distance classic races, such as Le Mans.

Finally, I did not say "it is not difficult to imagine cars with General Motors, Chrysler and Ford engines being faster than the existing Formula 1 Ferraris." What I did say was "it is not difficult to imagine the *power to weight ratio* of Formula Senior cars fitted with these engines matching the existing Formula 1 Ferraris." That, of course, is a very different thing. Sidney Allard's new sprint car has a superior power to weight ratio to the Formula 1 Ferrari, but it would be much slower on any normal racing circuit. Although this is taking an extreme case, the same principles, of course, apply.

It is very interesting, incidentally, that since I wrote the article, two large American interests have come up with similar ideas for a new Formula specifically to replace the dying Inter-Continental Formula.

I wonder, if the proposed rules were modified to admit Grand Touring engines to Formula Senior, whether we might see the re-entry of Aston Martin to racing circuits. If this were likely, there is no doubt that race-goers all over the country would welcome it. Motor racing today needs some of the big names to return.

Yours faithfully,

BRIAN LISTER.

Cambridge.
20 September, 1961.

Governor for Diesel Fuel Pump

SIR, I read with interest your article entitled "French Governor for Diesel Fuel Pump" (ENGNG., 1 Sept. '61, p. 262). I am, however, having difficulty in understanding certain aspects of the operation of this governor.

The quantity of fuel required by a diesel engine running under no load conditions is, I believe, approximately one-fifth of the maximum fuel. Under no load conditions, therefore, the shuttle piston must have only one-fifth of its full load travel.

Now, as the quantity of fuel which can pass through a given choke at a given pressure (in this case the average spring pressure) is proportional to time, it follows that only if the no load cyclic time is five times the full load cyclic time will the fuelling conditions be met.

This means that an engine set to run at 2,000 rpm full load will, on removal of the load, run at 10,000 rpm, that is, 500 per cent drop as opposed to the accepted figure of between 4 and 20 per cent.

If, as it seems more probable, I have failed to grasp the method of operation, I should be very pleased if one of your readers could enlighten me.

Yours faithfully,

N. T. BEESLEY.

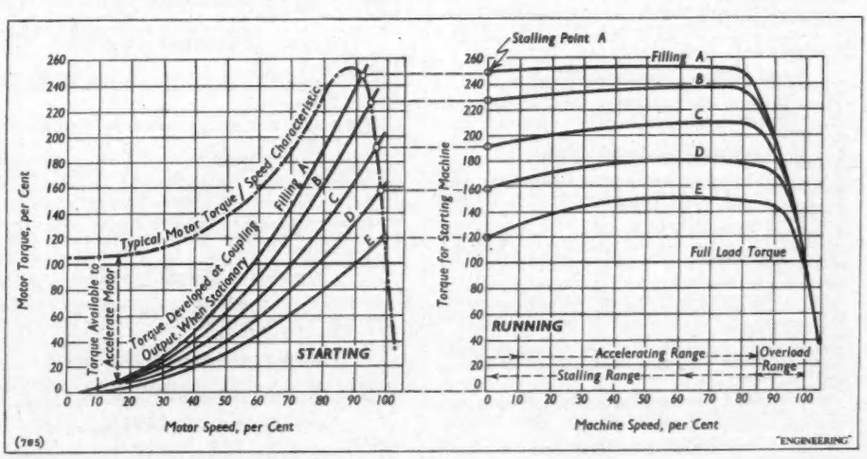
Staines,
Middlesex.
13 September, 1961.

Two-Element Fluid Couplings

SIR, The further letter of Mr. G. Monaghan on the subject of two-element fluid couplings (ENGNG., 11 Aug. '61, p. 165) has just been drawn to my attention.

In this letter he seeks to analyze the results of a fluid coupling under (*a*) normal load conditions, (*b*) overload conditions, and (*c*) stalled conditions. The figures quoted indicate that for (*a*), that is, 100 per cent torque demand, the power supplied is 100 per cent and the torque ratio is 1/1, which is obviously correct.

It is then stated, however: "Though the runner is stalled it exerts a torque: twice the maximum



Combined characteristics of direct-on started standard squirrel cage motor and traction-type fluid coupling. The left-hand graph shows how, at starting, torque at the coupling output shaft builds up as the motor speed increases, depending on the filling used. The right-hand graph shows typical output torque/speed characteristics of the driving unit during running.

torque exerted on the impeller." In actual fact, for a fluid coupling which is chosen to limit the power transmission to 200 per cent when the runner is stalled, it will be found that the impeller has to exert this amount also, as the ammeter on the motor will clearly show.

This point may be illustrated as shown on the accompanying illustrations. The left-hand graph shows a typical motor torque speed curve and the build-up of the torque developed at the output side of the fluid coupling is shown for various amounts of oil filling.

Assuming filling " C " is adopted, which would transmit a maximum of about 200 per cent full load torque, when the driven shaft commences to rotate the torque will normally fall towards the full load torque point, when the slip will be a nominal amount, say 2 per cent, as in Mr. Monaghan's example. If the torque demand be increased to 140 per cent, the corresponding output speed will be somewhere in the region of 96 per cent, but the torque ratio will still be 1/1, since the motor will certainly have to put into the system the additional torque.

As previously stated, the maximum torque transmitting capacity can be varied as shown on this graph by varying the quantity of oil, but the overload torque will always be reflected on the motor ammeter when the coupling is stalled.

Mr. Monaghan states that the fluid coupling gives flexibility to the transmission and this is true, but the writer is not aware of any two-element fluid coupling, whether driven by electric motor or engine, which will develop more torque than the motor or engine will put into the system.

J. BILTON,
Chief Engineer.

Fluidrive Engineering Company Limited,
Isleworth, Middlesex.

14 September, 1961.

Events in Advance

Meetings and Papers

The address and telephone number of the headquarters of each institution are given at the end of this list. Meetings in the headquarters town are held there unless otherwise stated.

British Institution of Radio Engineers

BRISTOL
" General Introduction of Inertial Navigation," by R. Collinson; and " Components and Techniques Employed in Inertial Navigation Systems," by E. Bristowe. South Western Section. School of Management Studies, Unity Street, Bristol. Wed., 11 Oct., 7 p.m.

NEWCASTLE UPON TYNE
" Very-High-Frequency Communications Receivers and Transmitters Using Transistors," by A. J. Rees or B. S. Cowle. North Eastern Section. Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 11 Oct., 6 p.m.

East Midlands Metallurgical Society

DERBY
" Some Aspects of Metallurgical Training," by M. I. McIntyre. Derby and District School of Art, Derby. Thurs., 12 Oct., 7.30 p.m.

Illuminating Engineering Society

LONDON
" The Society's Contribution to Lighting Technology "; Presidental Address, by W. T. Souter. Royal Institution, Albemarle Street, W1. Tues., 10 Oct., 6 p.m.

LIVERPOOL
Chairman's Address, by N. Blackman. Liverpool Centre. Industrial Development Centre, Paradise Street, Liverpool. Mon., 9 Oct., 6 p.m.

MANCHESTER
" The Society's New Code," by J. G. Holmes. Manchester Centre. Demonstration Theatre, North Western Electricity Board, Town Hall Extension, Manchester 2. Thurs., 12 Oct., 6 p.m.

NOTTINGHAM
Chairman's Address, by H. J. Slater. Nottingham Centre. Electricity Offices, Carrington Street, Nortingham. Thurs., 12 Oct., 6 p.m.

STOKE-ON-TRENT
" Stage Lighting," by B. Legge. Stoke-on-Trent Group. North Stafford Hotel, Stoke-on-Trent. Tues., 10 Oct., 6.30 p.m.

Institute of Marine Engineers

LONDON
" A Critical Survey of Marine Water-Treatment Methods," by I. Raleigh. Tues., 10 Oct., 5.30 p.m.

BRISTOL
" Water Treatment for High-Pressure Marine Boilers," by Dr. T. V. Arden and F. C. Blight. West of England Section. Small Engineering Lecture Theatre, The University, University Walk, Bristol 8. Mon., 9 Oct., 7.30 p.m.

GLASGOW
" Safety at Sea," by J. W. Bull. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Wed., 11 Oct., 7.30 p.m.

NEWCASTLE UPON TYNE
" Design and Layout of a 22,000 s.h.p. Tanker Machinery Installation," by J. B. Main. North East Coast Section. Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne. Thurs., 12 Oct., 6.15 p.m.

PLYMOUTH
" Marine Refrigeration Machinery," by Lieut.-Commander M. B. F. Ranken. Devon and Cornwall Section. Offices of the South Western Gas Board, Radiant House, Derry's Cross, Plymouth. Tues., 10 Oct., 7.15 p.m.

Institute of Metals

BIRMINGHAM
" Some Problems in the Development of Fuel Cells," by A. D. S. Tantram. Birmingham Local Section. College of Advanced Technology, Gosta Green, Birmingham. Thurs., 12 Oct., 6.30 p.m.

GLASGOW
" Physical Methods of Analysis for Major Alloying Constituents," by K. M. Bills. Scottish Local Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. Mon., 9 Oct., 6.30 p.m.

SWANSEA
" Welding of Non-Ferrous Metals," by J. G. Young. South Wales Local Section. Metallurgy Department, University College, Swansea. Tues., 10 Oct., 6.30 p.m.

Institute of Road Transport Engineers

BIRMINGHAM
" Research on the Testing and Performance of Commercial Vehicle Brakes," by R. D. Lister. Midlands Section. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Tues., 10 Oct., 7.30 p.m.

BRISTOL
" Wheels Round the World ": Film and Discussion. Western Centre. Royal Hotel, Bristol. Tues., 10 Oct., 7.30 p.m.

CARDIFF
" Wear and Tear," Part II, by J. E. Johnson. South Wales Centre. South Wales Institute of Engineers, Park Place, Cardiff. Fri., 13 Oct., 7.15 p.m.

SOUTHSEA
" Wheels Round the World " and " Off the Beaten Track ": Films and Discussion. Southern Centre. Cambridge Hotel, Southsea. Wed., 11 Oct., 7.30 p.m.

Institution of Civil Engineers

LONDON
" Site Organization ": Informal Discussion, to be introduced by R. S. Read. Tues., 10 Oct., 5.30 p.m.
" Some Developments in the Activated Sludge Process," by J. McNicholas. Thurs., 12 Oct., 5.30 p.m.

Institution of Electrical Engineers

LONDON
" Trends in Computer Engineering," Chairman's Address, by W. S. Elliott. Measurement and Control Section. Tues., 10 Oct., 5.30 p.m.
" Research in the Field of Electricity Utilization," Chairman's Address, by Dr. H. G. Taylor. Utilization Section. Thurs., 12 Oct., 5.30 p.m.

BELFAST
" Planning in the Electric Power Supply Industry," Chairman's Address, by Dipl. Ing. W. Szwander. Northern Ireland Centre. David Keir Building, Queen's University, Stanmillis Road, Belfast 9. Tues., 10 Oct., 6.30 p.m.

BIRMINGHAM
" Television Camera Tubes," by B. S. Pover. Annual General Meeting. South Midland Centre. BBC Engineering Department, Wood Norton, Birmingham. Mon., 9 Oct., 7 p.m.

CARDIFF
Chairman's Address, by T. Gill. Western Centre. South Wales Institute of Engineers, Park Place, Cardiff. Mon., 9 Oct., 6 p.m.

CARLISLE
" Progress in Oil-Fired Cables and Their Accessories," by Dr. A. N. Arman, Dr. Ing. F. J. Miranda and G. R. Bishop; and " The Influence of Ageing on the Characteristics of Oil-Filled Cable Dielectric," by Dr. Ing. P. Gazzana-Priaroggia, Dr. Ing. G. L. Palandri and Dr. Chem. U. A. Pelagatti. North Eastern Centre. Carlisle Technical College, Carlisle. Wed., 11 Oct., 7 p.m.

DUNDEE
Chairman's Address, by Professor E. G. Cullwick. North Scotland Subcentre. Electrical Engineering Department, Queen's College, Dundee. Thurs., 12 Oct., 6 p.m.

NEWCASTLE UPON TYNE
Chairman's Address, by P. Richardson. North Eastern Centre. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 9 Oct., 6.15 p.m.

Institution of Engineers-in-Charge

LONDON
" Sources of Technical Information," Presidential Address, by Dr. Ezer Griffiths. Caxton Hall, off Victoria Street, SW1. Wed., 11 Oct., 6.30 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
" Aspects of Boiler Chimney Design to Avoid Corrosion and Smut Emission," by W. R. Carter. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Tues., 10 Oct., 6.30 p.m.

BRISTOL
" Methods of Measurement," by J. M. Cooling. South Western Branch. RWA School of Architecture, Bristol. Tues., 10 Oct., 6.30 p.m.

Institution of Highway Engineers

LONDON
" Road Accidents: Remedy or Revenge? " by J. J. Leeming. Institution of Structural Engineers, 11 Upper Belgrave Street, SW1. Fri., 6 Oct., 5.30 p.m.

Institution of Mechanical Engineers

LONDON
" Design and Manufacture of Cigarette Making Machines," by Desmond Molins. Nominated Lecture. Wed., 11 Oct., 6 p.m.

Institution of Production Engineers

LONDON
" Can Electrochemical Cutting Complete? " by D. J. Fishlock. London Graduate Section. Thurs., 12 Oct., 7.15 p.m.

BRISTOL
" Management-Trade Union Relationship in Industry," by S. J. West and P. E. Stanford. Western Graduate Section. Faculty of Engineering, Queen's Building, The University, Bristol. Wed., 11 Oct., 7.30 p.m.

COVENTRY
" Future Trends in Machine-Tool Design," by Professor J. Loxham. Coventry Graduate Section. Offices of Courtaulds Limited, Lockhurst Lane, Coventry. Wed., 11 Oct., 7.30 p.m.

PETERBOROUGH
" Ball and Roller-Bearing Manufacture," by J. Anderson. Peterborough Section. Offices of F. Perkins Ltd., Peterborough. Wed., 11 Oct., 7.30 p.m.

Institution of Structural Engineers

LONDON
" Professional Practice and Drawing Office Procedure," by L. R. Creasy. Thurs., 12 Oct., 6 p.m.

MIDDLESBROUGH
Chairman's Address, by L. Dobson. Northern Counties Branch. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough. Thurs., 12 Oct., 6.30 p.m.

Junior Institution of Engineers

LONDON
" The Technician, Education and Industry," by J. Heywood. Fri., 13 Oct., 7 p.m.

Manchester Metallurgical Society

MANCHESTER
Presidential Address, by W. L. Harper. Manchester Literary and Philosophical Society, George Street, Manchester. Wed., 11 Oct., 6.30 p.m.

Radar and Electronics Association

LONDON
" Space Communications," Part I, by L. F. Mathews. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 12 Oct., 6 p.m.

Reinforced Concrete Association

BIRMINGHAM
" Architectural Uses of Concrete in the Far East," by Philip Langley. Midland Counties Branch. Birmingham and Midland Institute, Paradise Street, Birmingham. Tues., 10 Oct., 6 p.m.

Royal Statistical Society

LONDON
" Variability of Quota Sampling," by T. Corlett. General Applications Sections. 28 Portland Place, W1. Tues., 10 Oct., 6.15 p.m.

EDINBURGH
" Application of Statistics to Traffic Engineering," by R. Hodgen. Edinburgh Group. Mathematical Institute, Chambers Street, Edinburgh. Tues., 10 Oct., 7.30 p.m.

Society of Instrument Technology

LONDON
" Process Control in Paper Mills," by H. B. Whitehouse and M. I. MacLaurin. Control Section. Manson House, 26 Portland Place, W1. Wed., 11 Oct., 7 p.m.
" The Inspiration of Science," by Sir George Thomson. The Thomson Lecture. Royal Institution, Albemarle Street, W1. Thurs., 19 Oct., 6 p.m.

BIRMINGHAM
" Differential Producers for Flow Measurement," by H. E. Dall. Midland Section. Gosta Green College of Technology, Aston Street, Birmingham. Fri., 13 Oct., 7 p.m.

DERBY
" The Commonsence Approach to Instrument Manufacture," by C. E. T. Cridland. East Midland Section. Derby and District College of Technology, Kedleston Road, Derby. Thurs., 12 Oct., 7.30 p.m.

LIVERPOOL
Film Display. Liverpool Section. Industrial Centre, Merseyside and North Wales Electricity Board, Paradise Street, Liverpool. Thurs., 12 Oct., 7 p.m.

MANCHESTER
" Instrumentation as an Aid to Fuel Efficiency," by R. Clare. Manchester Section. Literary and Philosophical Society, 36 George Street, Manchester 1. Mon., 9 Oct., 6.45 p.m.

Tyne Wear Metallurgical Association

NEWCASTLE UPON TYNE
" Modern Developments in Steelmaking," by J. Pears. Metallurgy Department, King College, Haymarket, Newcastle upon Tyne. Mon., 9 Oct., 6.30 p.m.

West of England Metallurgical Society

BRISTOL
" Creep: The Potential Influence of Theory in Practice," by Dr. D. McLean. College of Science and Technology, Ashley Down, Bristol 7. Fri., 13 Oct., 7 p.m.

British Institution of Radio Engineers, 9 Bedford Square, London WC1. (MUSeum 1901)
East Midlands Metallurgical Society. Apply to Mr. H. L. Parker, 4 Aylesbury Avenue, Chaddesden, Derby.
Illuminating Engineering Society, 32 Victoria Street, London SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London SW1. (BELgravia 3291)
Institute of Road Transport Engineers, 1 Cromwell Place, South Kensington, London SW7. (KENsington 3744)
Institution of Civil Engineers, Great George Street, London SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WC2. (COVent Garden 1871)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street, London SW1. (ABBey 3891)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London SW1. (WHItehall 7476)
Institution of Production Engineers, 10 Chesterfield Street, London W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London SW1. (VICtoria 0786)
Manchester Metallurgical Society. Apply to Mr. E. Holland, The Kennedy Press, Ltd., 31 King Street West, Manchester 3.
Radar and Electronics Association, 45-47 Mount Street, London W1. (GROsvenor 4477)
Reinforced Concrete Association 94-98 Petty France, London SW1. (ABBey 4504)
Royal Statistical Society, 21 Bentinck Street, London W1. (WELbeck 7638)
Society of Instrument Technology, 20 Queen Anne Street, London W1. (LANgham 4251)
Tyne Wear Metallurgical Association. Apply to Mr. J. K. O'Hanlon, C. A. Parsons and Co, Ltd, Fossway, Newcastle upon Tyne 6.
West of England Metallurgical Society. Apply to Mr. P. C. Thornton, College of Technology, Bristol.

Larger Engines and Disc Brakes for the Cooper Minis

By Gordon Wilkins

Since production of the BMC Miniminor and the corresponding Austin version began, it was realized that the outstanding steering and road holding characteristics would permit an engine with an increased performance to be built into the standard model. During the past two years a number of engine conversions have been placed on the market by performance tuning specialists, and servo brakes with anti-fade linings have been used to cater for the increased performance.

The BMC have now joined with the exploiters in utilizing the experience gained by Cooper cars in the modification of the BMC A-Type power unit for their Formula Junior racing cars. The new models are named the Morris Mini-Cooper and Austin Seven Cooper. The extra engine power has been obtained partly by increasing swept volume, and partly by improving the breathing and raising the revolution speed. The cylinder bores have been slightly reduced but the stroke is increased by 19·2 mm, the new dimensions being 62·43 × 81·28 mm (the original engines being 62·9 × 68·26 mm) to give a swept volume of 997 cc; this is an increase of 17½ per cent. A new cylinder head similar to that used on the Austin Healey Sprite Mark II and the MG Midget is fitted with larger inlet valves and ports, double valve springs and a modified combustion chamber shape. Two SU HS2 carburettors are used and there is a three branch exhaust system. Compression ratio is raised from 8·3 to 9 to 1 which is still within the operating limits for premium grade fuel, and the camshaft has been modified to increase the valve overlap. These modifications gave an installed output of 55 bhp at 6,000 rpm against 34 bhp at 5,500 rpm in the standard model, and maximum torque is 54·5 lb ft at 3,600 rpm. In view of the increased speed range of the engine, the crank webs have been thickened and the diameter of the crankshaft increased adjacent to the out-rigged flywheel. A further insurance against torsional vibration is found in the fitting of a damper to the nose of the crankshaft.

Since many of these cars will be acquired by enthusiastic drivers interested in making the best use of the gearbox, a new remote control gear shift has been designed, with a short upright lever close to the driving seat. By raising the maximum speed to nearly 90 mph with a corresponding boost to acceleration these modifications have greatly increased the work done by the brakes and Lockheed disc brakes have been incorporated on the front wheels. Normally the front wheels carry 60 per cent of the kerb weight of the car. However, the effect of weight transfer during braking and a relief valve offloading the pressure in the rear brake lines, which prevents rear wheel locking, means that in crash stops the front brakes are doing up to 80 per cent of the work.

Since the addition of disc brakes, the conventional comparisons based on friction lining area have become meaningless and the more realistic assessment is the area of metal swept by the linings. On this basis the area at the front wheels is increased from 55 to 208 sq. in and the overall swept area goes up from 110 to 263 sq. in. As a result it is claimed that the new brakes, which bring the Cooper Mini to a standstill from 90 mph, are stressed no harder than the standard brakes stopping the normal car from 60 mph.

The new models are given dual colour schemes and a standard of trim and finish in keeping with their high technical qualities. Externally they are distinguished by new polished metal radiator grilles, bright metal frames for the top half of the doors and special name plates. Careful attention has been given to sound damping by the use of linings on the body panels and sound deadening emulsion in the wheel arches. Inside, the trim on doors and roof lining is improved and there are new front seats with larger cushions and back rests. Metal levers replace the lengths of wire used to work the door latches. There is a new oval instrument panel with oil pressure gauge and thermometer grouped round the central speedometer, which also incorporates the fuel gauge and usual warning lights.

The finish of the luggage rack is also improved. The inside of the lid is properly panelled in plastic and above the spare wheel is a flat shelf covered in carpet to match that used on the floor of the car interior. For buyers who want the high quality finish without the extra performance there are new super versions of the normal Mini and Austin Seven. These have all the improvements in trim and body that are found on the Cooper cars but have different radiator grilles based on those of the standard models with the addition of vertical strips. Both the Austin and the Morris grilles for these versions are in bright metal. With four new radiator grilles for the above models plus the standard ones, the two versions of the vans and pick-ups which use one grille with different badges and the Mini-Beach car, there are now no fewer than nine different front ends for Mini.

Power unit of the Cooper Mini, showing the twin SU carburettors and banana tube exhaust system.

Improved interior finish on the Cooper Mini is also made available in the Super Mini, which retains the original engine.

Prices in the United Kingdom for the Cooper versions are as follows: Austin Seven Cooper and Morris Mini Cooper: basic price £465, total price (including purchase tax) £679 7*s* 3*d*; Austin Seven Super and Morris Super Mini Minor: basic price £405, total price (including purchase tax) £591 17*s* 3*d*.

Ford Coupé with Sporting Line

Having established a reputation for producing cars in the small to medium range possessing a strictly functional nature, Ford have introduced an entirely new concept into their light car design. It takes the form of a prestige car offering custom-built appearance combined with extreme comfort and the benefits in economy which can only be obtained from a large manufacturer.

Called the Consul Capri, the new car is in effect a sports coupé version of the recently introduced Consul 315. It can accommodate two people in front in large foam-cushioned adjustable bucket seats and has room behind for either an occasional seat for children or a large amount of luggage. In addition, the 22 cu. ft boot of the Classic is retained, making it an ideal touring vehicle for two people. The two doors are wide with frameless windows and give access to a well appointed interior with deep-pile carpets and an air of roominess. The headlining is washable and the sun-vizors neat and well-padded. Instrumentation is similar to the Classic, situated in a hooded cluster.

Combining attractive appearance and impressive performance with good handling characteristics the Consul Capri should be popular with the man who wants something different for a modest outlay.

The most striking feature of the Capri is its low 4 ft 4 in roofline, which in one sweeping "aerofoil" contour embraces the sharply-raked double-curved windscreen and rear window. For ventilation there are hinged front quarter lights, "wind-down" side windows and large rear quarter lights which retract into the body. In conjunction with the heater they ensure balanced warmth and ventilation in most conditions. There is no pillar between the windows and rear quarter lights and with both lowered there is an unbroken line from front to rear.

Mechanically the Capri is the same as the Consul 315 and has the 1,340 cc ohv pushrod engine developing 54 bhp at 4,900 rpm. There are disc brakes on the front wheels and the four-speed gearbox can be supplied with floor or steering column control. Dimensions are similar to those of the Consul 315 and weight is the same as the two-door version which has a kerb weight of 2,025 lb. Top speed of the Capri is said to be over 80 mph.

At the same time, an estate version of the successful Anglia is announced. A logical development of a body well suited to this adaptation, it should attract much attention in this popular field of the dual-purpose vehicle combining saloon car comfort with the load capacity of a van when required.

XUM

Human Element

Lessons from Swedish Shipbuilding Productivity

This month the British Productivity Council have published the report made by the joint management/trade union team which visted Swedish shipbuilding yards on the Council's behalf in late 1959 (*Price 5s*).

After seeing how the Swedes have obtained their impressive production levels, one of the main suggestions made by the team is that the Shipbuilding Employers' Federation and the Confederation of Shipbuilding and Engineering Unions should investigate manpower utilization. This might not be a startlingly original idea or opinion but, coming from a team of leading trade unionists and members of management after an objective study of someone else's production facilities and methods, it must now have substantial and responsible support.

The team did not find Swedish manufacturing equipment and methods significantly different from those in this country and the same is true, they consider, of yard organization and the calibre of individual managers and men. They also concluded that while the Swedish industry's decision to concentrate on bulk carrier and cargo vessels has undoubtedly made for reduced costs, as has the system of tax relief on capital investment, they "contribute only a minor proportion of the reduced cost and high rate of output." The major proportion was simply a question of the relatively high output, or productivity, of individual labour.

Flexibility of Labour

This individual productivity, says the report, "arises from the allowable flexibility of labour and employers—flexibility in that any man within the industry is free to do any work within his physical and technical ability, and discipline in that labour and management respect and honour the decisions and agreements of their elected representatives." On the point about flexibility of labour, the trade union members have added a qualifying note that this is "mainly to avoid redundancies or to relieve bottlenecks, and not practised promiscuously, as contended by the employers' delegation."

Nevertheless, whatever the correct emphasis might be here, the fact is that the Swedes do not have to share our irritating periodic experience of seeing an important national industry grinding to a wasteful standstill over the apparently childish type of squabble which has come to be known by the pompous title of "demarcation dispute." Sometimes these stoppages are caused by a failure of management to explain their policies at the right time and sometimes they are caused by a local trade unionist hot head (the trade unions, of course, play a vital part in maintaining industry's forward momentum, but an individual trade unionist can be as subjective and blinkered as any other individual and the sooner everyone recognizes that this is not an indictment of the trade unions themselves, the better) but these particular causes are not important on their own account. What is important is that they are symptomatic of the immobility of mind in the industry. It appears that the Swedes might have an important advantage in the fact that all the workers organized within each of their industries are in the same union. However, there are encouraging indications that our own shipbuilding unions are coming closer together.

Legal Powers

The BPC report points out that "these principles of flexibility and discipline are common to Swedish industry nationally and the prime reason for shipbuilding productivity is not peculiar to the industry itself but results from the national framework of labour/employer organization." Broadly speaking, this framework is that industry is free to order its own affairs and make its own agreements, but the State has established the disciplinary measures necessary to ensure that responsibility for these affairs and these agreements is discharged. Agreements between employers and trade unions can be enforced by law and, further, abortive negotiations must be discussed before a government mediator. If such mediation fails, one week's notice must be given of strikes or lockouts.

In Sweden, the shipbuilding employers have no association of their own, but 38 individual firms are members of the Swedish Metal Trades Employers' Association and have about 24,000 of the total of 165,000 employed by all the association's member firms. There is no specific negotiating organization for shipbuilding but it has members on the association's governing body who are present at negotiations which concern the industry. The trade unions are organized on a national basis in the Swedish Confederation of Trade Unions.

At local level, the BPC team considered that the Works Committees (or Enterprise Councils, to give a closer translation) in the individual firms made a significant contribution to the Swedish industry's high productivity. These committees are set up for, among other things, continuous collaboration between employers and employees to attain the highest possible production. The employer must keep workers informed of the firm's technical and financial situation so that employees can submit their ideas for improving production and conditions. Perhaps our own industry would benefit more from such committees if some employers were quicker to appreciate that these bodies can evoke worthwhile ideas from employees if they are genuine committees, instead of mere safety valves.

The eight-man team was led by Mr. C. Stephenson, of Joseph L. Thompson and Sons, and the three other employers' representatives were Mr. G. S. Moss, of Cammell Laird, Mr. N. A Sloan, of the Shipbuilding Employers' Federation, and Mr. J. M. Winders, of Charles Connell and Company. Representing the trade unions were Mr. H. G. Barratt, of the Confederation of Shipbuilding and Engineering Unions, Mr. W. H. Bradley, of the Amalgamated Engineering Union, Mr. E. J. Hill, of the United Society of Boilermakers, Shipbuilders and Structural Workers, and Mr. A. Williams, of the Shipconstructors and Shipwrights' Association.

Keeping Work Study Engineers on the Ball

The success of a work study department must lie as much in the liveliness, freshness and objectivity of its approach to its problems as much as in its basic technical and specialist knowledge. Appreciating this point, British Insulated Callender's Cables Limited are keeping their work study engineers in the main stream of up-to-date work study thinking and practice by holding a two-day conference at their Prescot, Liverpool, works on the 12 and 13 October.

The conference will be opened by Mr. R. M. Fairfield, BICC's assistant managing director, and there is to be an imposing list of speakers. On the first day they will include Mr. P. A. Wood and Mr. R. Whitaker, both of ICI, Mr. G. St. G. Wheeley of Unilever, and Mr. Ted Fletcher, formerly of the TUC and now of Associated Industrial Consultants Limited. Their subjects will include "The Place of Work Study in an Organization," "Work study and Management Training," and "Work Measurement in the Office."

On the second day, Professor R. W. Bevans, of Manchester University, will discuss "The Scope and Limitations of Operational Research." The following speakers will be Mr. P. R. Bergson, a methods-time measurement expert from GKN Group Services Limited, and Miss Anne Shaw, of the Anne Shaw Organization, whose subject will be "Modern Method Study." Mr. P. M. Burman, BICC's chief work study engineer, will wind up the conference.

In bringing together these elder statesmen—and the elder stateswoman—of British work study, BICC deserve to succeed in their aim of "affording the work study staff at Prescot an invaluable opportunity of applying to their own work the stimulus of objective examination and critical appraisal as a result of hearing and questioning the speakers."

House Journal with a Difference

Since the war, the house journal has become increasingly widely recognized as an important tool in promoting good relations and good communications within a firm and in creating that important element of industrial mystique, "company spirit." At first, the journal tended to be a big and colourful "glossy" exuding comfortable and monotyped affluence—something worth identifying with. Nowadays, there has been a general switch to the more economical and less brashly publicity-seeking newspaper format, a change which might be taken to indicate that the house journal is now seen to make a genuine constructive contribution to industrial relations that no longer needs screaming from the housetops.

Most house journals, though, are published by factory based industrial units to meet the needs of permanent and farily self-contained groups of workpeople with an obvious communal interest. The *Trawsfynydd Site News*, however, is a house journal in newspaper format published by Atomic Power Constuctions for the people working on the construction of the nuclear power station at Trawsfynydd (ENGNG., 18 Aug., p. 212). There are other journals, such as the Laing Group's *Team Spirit*, published by construction companies to cover all of their activities for the information of all their employees, but this is an unusual example of a journal floated specifically for one particular construction job.

In fact, the Trawsfynydd construction project is one for which a house journal is ideally suited. The whole of the production and construction activities must be precisely programmed and integrated to avoid the possibility of a minor delay at, say, one of the smaller sub-contracting factories throwing the schedules out of gear and starting a chain reaction of delays and bottlenecks among the other contractors and sub-contractors. Good communications and the maintaining of interest in the end product are therefore vital, but they are made difficult by the fact that production work is divided between the isolated construction site and a number of distant factories. The *Trawsfynydd Site News* helps to give to people scattered between site and factory the collective spirit and common interest that are necessary in an industrial undertaking but are more easily attained when the production units are under one roof. In the case of the people working on site, miles from the rest of civilization, the journal also fills a social need.

In addition to reporting progress on the construction work, the journal gives news of developments in the power generating field, of measures that can promote safety on site, of local education facilities and of any topical technical and general subjects that would interest people working at or for Trawsfynydd. In other words, it is a serious, and not a flippant, house journal.

BSI Code for Electric Motor Control Gear

A new Code of Practice on the maintenance of electric motor control gear has been published by the British Standards Institution, under the authority of the Council for Codes of Practice, and should be useful to all concerned with the maintenance and management of electrically powered industrial plants. The various statutory regulations with which electrical installations may have to comply are indicated, together with such important general matters as inspection, observance of manufacturers' instructions, and the analysis of faults.

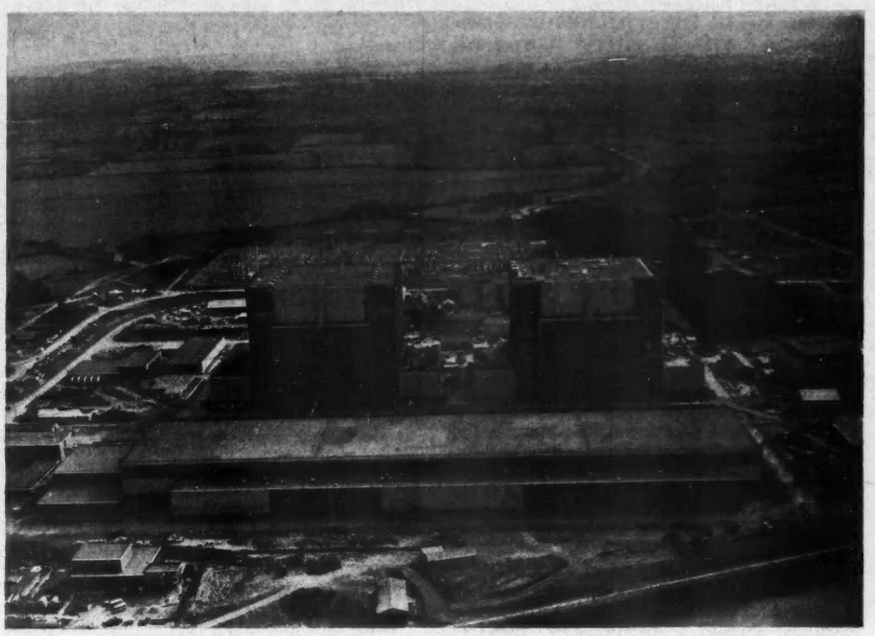
An important section deals with the safety of personnel operating installations, and emphasizes such important precautions as isolation before maintenance work begins; the use of voltage indicators; special precautions in dealing with oil-immersed equipment; and the maintenance of earthing connections. Notes are included on first-aid and fire extinguishing equipment.

The main section of the code sets out general principles of maintenance which are applicable to most types of equipment, followed by detailed recommendations for various types of control gear such as contactors, drum controllers, overload and time-delay devices, liquid starters and controllers, push button and similar auxiliary devices, isolators and composite units of switches and fuses. There is a useful list of special equipment (other than tools normally used by the electrician) which may be needed to carry out the recommendations of the code.

Copies of the Code, CP 1011, may be obtained from the British Standards Institution, British Standards House, 2 Park Street, London W1 (6*s*).

Third Nuclear Station Nears Completion

Both Bradwell and Berkeley achieved criticality last month and the third civil station—Hinkley Point—hastily nears completion. The first reactor is due to go critical late next year, and the second will follow six months later.



An aerial view of Hinkley Point power station looking south. In the foreground is the turbine house and on the right No. 1 reactor which is due to go critical late next year.

SIX YEARS is a comparatively short time for the construction of one of the present range of nuclear power stations in the Central Electricity Generating Board's programme. Hinkley Point is the third of the stations in the programme, and the first with a capacity of 500 MW; the two earlier stations are Bradwell, which went critical on 19 August, 1961, and is designed to produce 275 MW, and Berkeley which went critical nine days later on 28 August and will produce 300 MW. The English Electric, Babcock and Wilcox, Taylor Woodrow Atomic Power Group are responsible for the construction of Hinkley Point, which is on the Bristol Channel, south-west England.

Hinkley Point has the advantage that the subsoil is relatively shallow and there is a good rock foundation. During the construction approximately 700,000 cu. yd of soil and clay and about 32,000 cu. yd of rock have been excavated for the foundations of reactors 1 and 2 and for the blower house.

The starting date for the contract was 15 December, 1957, and the first reactor will be in operation by the end of next year and the second by the end of 1963. The foundations and the main concrete work, including the biological shields, for the two reactors, turbine house and blower house are now complete. For these about 300,000 cu. yd of concrete have been used. The greater part of the turbine house area has been reclaimed from the shore by the construction of a mass concrete sea wall over 3,300 ft long which rises 29 ft above ordnance datum level.

The turbine house is situated on the seaward side of the reactors and is 740 ft long by 130 ft wide, the basement being 30 ft below ground level. The construction of the turbine house is also basically complete and the machinery is being assembled. The machinery will comprise six 93·5 MW turbo-alternators and three 33 MW variable speed turbo-alternator sets of which one will act as a standby set. This last set will supply the blower motors and will give a speed range from 750 to 3,000 rpm. The carbon dioxide coolant gas is circulated through the reactor and heat exchangers by axial flow blowers driven by 7,000 hp squirrel cage induction motors.

Both the reactor pressure vessels have been pressure tested and stress relieved. In the first reactor the grid plate is being placed in position, and the stand pipes and control charge nozzles are being welded in. After obtaining clean conditions inside the vessel, graphite laying will commence by the end of year. The graphite has been manufactured in a special machine shop at the English Electric factory, Whetstone.

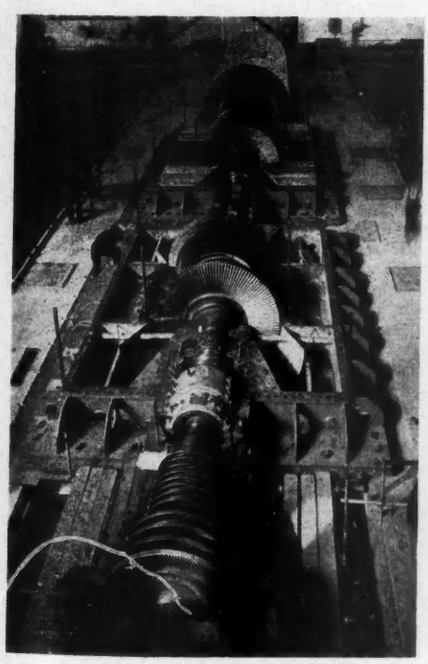
The heat exchangers and high and low pressure boilers for the first reactor are *in situ* and work is proceeding with assembly of associated pipework and tubing. Work has commenced on the cutting of holes in the reactor pressure vessels for the charge and control standpipes. Work is in progress on the fabrication and welding of the standpipes and control charge nozzles, and heat exchangers for the second reactor. Temporary workshops have been built for the prefabrication of heat exchangers and pressure vessel sections.

In operation the station will require 35 million gallons of sea water per hour for cooling purposes. Two 11 ft diameter tunnels at 60 ft below ordnance datum level have been driven approximately 1,800 ft from the pumphouse behind the sea wall. The tunnel will terminate at an intake structure which was constructed in a dry dock on site. The structure is largely complete, having been floated into position in June, 1959, and founded on eight 4 ft diameter steel legs.

The intake system has been designed to supply a possible second station adjacent to the one under construction, with additional water requirements of 50 million gallons per hour.

The excavation for the cooling water pumphouse is complete, plus the concrete structure of the pumpwell and forebays, and work is now proceeding with the preparation of cooling water pump and screen mountings. The inlet culverts to the turbine house are complete and the outlet culverts from the turbine house to seal pit are approximately 95 per cent complete.

An 18 ft diameter access shaft for the cooling water intake tunnels has been sunk approximately 100 ft and lined with cast iron segments. Work is proceeding to schedule on the construction of the intake tunnels. Driving of the 7 ft diameter access tunnel is finished, and the two intake tunnels have been driven and lined for approximately 1,750 ft.



One of the six English Electric 93·5 MW main hydrogen cooled turbo-alternator sets being assembled.

The six vertical centrifugal pumps for delivering cooling water. Each pump delivers 93,000 gallons per minute.

The Widening Concept of Quality Control

At the Fifth International Conference on Quality Control, held this month in Turin, it was apparent that the concept of quality control is widening. Indeed the technique has extended into virtually every field of industrial activity. It is becoming very much a problem of integration, management and organization.

THE EUROPEAN ORGANIZATION for Quality Control held this year's conference, its Fifth International Conference, in Turin from the 11 to 13 September. As shown in the programme in the Table, discussion of quality control took the conference into virtually every aspect of company activity—into research and development, design and production, reliability testing and marketing. One of the major developments since last year's conference in London seemed to be that there has been a more general and firmer crystallizing of opinion that the concept of quality control is widening to touch on all facets of a firm's operations.

This extending of the field of quality control has reached the point where it can meet industry's growing requirement for the corollary concept of integrated control. Appropriately, therefore, the theme of this year's conference was "Integrated Control of Product Quality."

Quality control, perhaps, can be said to be following the normal growth pattern of new (or comparatively new) industrial techniques and specialisms. After an early period of development in its different parts, particularly statistical quality control, it is emerging from the phase of experimentation and academic theorizing to be accepted as an integrated management aid, even in firms which tend to look conservatively upon management techniques and aids. Having reached this point of acceptability—and perhaps respectability—the problem for the emergent technique becomes one of consolidation and organization as much as of perfecting the technique itself.

MANAGEMENT PROBLEMS

In fact, the most urgent problems in quality control at present are problems of management rather than of technical expertise. This is why quality control engineers are becoming so urgently concerned with the new concept of integrating or managing the different quality control activities within a company or organization. Indeed, some of the more advanced practitioners and thinkers on the subject talk of quality control engineering developing into a technology in its own right.

This change of emphasis was reflected in the subject matter of the papers given in Turin. Some papers were concerned with technical developments—and were very important in keeping the conference delegates informed of the possible applications of these developments—but more of the papers were concerned with basically management problems—problems such as the relationship between particular quality control functions, or the factors to be considered in setting up integrated quality control, or the effect of quality control on overall company policy and potential.

To some degree, this developing consciousness of the importance of integrated quality control has been stimulated by the basic idea of "total quality control" which is now propagated by the American Society for Quality Control. By "total quality control," the American Society, whose President and other representatives were among the Turin conference speakers, have in mind a concept broadly similar to what European quality control engineers understand by "integrated quality control," though the difference in terminology does seem to reflect a subtle difference in approach. While European engineers appear to think in terms of integrating existing systems, the Americans talk in terms of the economic necessity for tackling quality control as a completely new overall problem.

The Conference Programme

Monday, 11 September
Morning Session
Chairman: *M. G. R. Prever (Italy)*
"Integrated Control of Product Quality, Its Aspects and Components" — *S. B. Littauer (USA)*
"Logical and Economic Aspects of Statistical Quality Control" — *F. Brambilla (Italy)*
Afternoon Session
Chairman: *M. J. Langendorff (France)*
"Quality through Marketing Research" — *M. J. Moroney and F. P. Thompson (Unilever, UK)*
"Interaction between Quality of Design and Quality of Production" — *G. Brynge (Sweden)*
"Integrated Control of Product Quality and the Manufacturer" — *F. G. Willemze (Holland)*
Tuesday, 12 September
Morning Session
Chairman: *M. M. J. Van Ettinger (Holland)*
"A Total Programme of Quality Control" — *A. V. Feigenbaum (USA)*
"Standardization as a Factor in Integrated Control of Product Quality" — *F. Goubeaud (West Germany)*
"Integrated Control of Product Quality and the Public Services" — *R. M. de Lorris (France)*
"Quality Control in a Public Service: Air Transport" — *P. Sautet (France)*
Tuesday, 12 September
Afternoon Session. Presentation of Case Studies
Chairman: *J. M. Juran (USA)*
"Steel Industry" — *G. Rossi and F. Gottardi (Italy)*
"The General Problem of Quality Control" — *P. Buisson (France)*
"The Cable Industry" — *Mrs. A. Zaludova and J. Sedlacek (Czechoslovakia)*
"The Electrical Industry" — *E. Blanco (Spain)*
"Cumulative Sum Techniques in Continuous Processes" — *W. D. Ewan (British Nylon Spinners, UK)*
"The Clothing Industry" — *J. Sittig (Holland)*
"The Paper and Pulp Industry" — *O. Lokki (Finland)*
Wednesday, 13 September
Morning Session
Chairman: *M. W. Masing (West Germany)*
"The Place of Research and Development in Integrated Control of Product Quality" — *M. Nepper (Belgium)*
"The Place of Research and Development in the Achievement of Reliability" — *E. H. Ingamells (English Electric Aviation, UK)*
"The Full Quality Control Cycle" — *P. Larizza (Italy)*

TABLE: *The Programme for the Fifth International Conference of the European Organization for Quality Control, held this month in Turin. 400 delegates were present, including 60 from Britain.*

While the scope and concept of quality control are widening within individual companies, they are also widening in the range of industries to which quality control is being applied. On the second afternoon of the conference, for example, case studies were given ranging from the steel to the cable industry, from nylon to paper, and from the clothing to the electrical industry. In fact, quality control is now acknowledged as a management technique of catholic application.

BRITISH INTEREST

There were 400 delegates present at this year's conference and they came not only from Western Europe but from the USA and from behind the iron curtain, from Czechoslovakia. A measure of British interest in the conference was the fact that there were more than 60 delegates from this country, four of whom (two of them jointly) gave papers. Of the discussion points raised from the floor of the conference, more than half, on a rough count, were raised by British delegates, the surest indication of the interest which quality control has aroused in the UK.

After the conference had been opened by Mr. Frank Nixon, of Rolls-Royce, in the unfortunate absence through illness of Signor Carlo Rossi, President of the Italian Quality Control Association, the first paper was given by Professor Littauer, of the USA. His subject, "Integrated Control of Product Quality, its Aspects and Components," was, in effect, a setting in perspective of the whole conference.

Professor Littauer described how integrated quality control aims at comprehensive, continuing self-corrective direction of operations by means of statistical controls "implemented as a human linked servo-control system." To do this it is necessary to develop an overall economic quality control cycle and corporate wide managerial controls, and to implement statistical controls and techniques of operational analysis.

If such a control cycle is effected, said the professor, and an analysis of operations is also made to set up effective scheduling, programming and inventory policy, it is possible to establish continuing statistical control of unit cost and effective optimization of production. Thus, integrated quality control can attain not only the most economic level of quality, but also the most economic total product cost. Most of the techniques needed for effecting integrated total control have already been developed and, said Professor Littauer with true American fervour, "the ambition and the faith necessary to carry out such a programme is the responsibility of management."

Next, Professor Brambilla, of Bocconi University, Milan, gave an academically profound paper on "Logical and Economic Aspects of Statistical Quality Control." He described how this control can be applied to any type of manufacture, irrespective of production quantities, by use of the concept of stationary stochastic processes. Professor Brambilla also proposed a form of linear programming suitable for optimizing production by statistical quality control.

After lunch on the first day, Mr. M. J. Moroney, a British delegate from Unilever Limited, presented a paper, "Quality through Market Research," which he had prepared in conjunction with one of his colleagues, Mr. F. P. Thomson. Market research, he pointed out, tends to be treated as a reliable part of product testing, particularly where the overall quality assessment of the product depends substantially on the reaction of the consumer to non-functional or only marginally useful characteristics.

Yet, as still most commonly practised in the product testing field, market research, argued the speaker, pays insufficient attention to fundamental problems of methodology, with the result that it is unduly influenced by fetishes of panel balance, paired testing and prompted responses. It has too great a faith in verbal questions and answers, and until such weaknesses in methodology are overcome, the value of market research will be inherently limited, and the temptation to prop up weak data by sophisticated interpretation will be great.

It seemed ridiculous to Mr. Moroney—and there were many who agreed with him during the ensuing discussion—that there can be such an unscientific skimping of panel tests, for example, when advertising costs are comparatively astronomical. In the present state of market research techniques, the speaker suggested, "If customers could not talk, market research would be on a much more scientific basis."

Those of us who are sick of being told that 50 per cent of drivers like yellow cars, or that every third man smokes filter tips, or that nine out of ten men prefer blondes, without anyone ever once asking *us* what *we* like, must now be relieved to know that the trouble is simply that the panels are too small for the market researchers to have got around to us yet. We had begun to think that our opinions weren't worth having.

However, there is no inherent reason why market research should remain in this unscientific state. The fundamental difficulties are essentially problems in the design and analysis of experiments, and these can be remedied by modern statistical techniques.

The second speaker of the afternoon, Mr. Gun-

nar Brynge, of Sweden, dealt with the "Interaction between Quality of Design and Quality of Production." He described how, in conditions of high volume modern production, quality control had become too big a problem to be considered in the production departments alone and it has therefore been necessary to turn to integrated quality engineering. At the same time, the reliability philosophy, originally developed in the missile field, has been extended to more commonplace products.

In this era of mass production and changing techniques and materials, said Mr. Brynge, engineering faces a situation where design for quality becomes a new and difficult problem. There are four main reasons for this development, namely, (a) the failing of new materials and processes; (b) the complexity of function and structure in automation; (c) the strain on parts and structure in the race for performance versus production cost; (d) the volume in mass production that makes testing a sophisticated statistical problem.

To meet these difficulties, Mr. Brynge advocated studying potential dangers as well as advantages in new techniques; using a "strategic personnel mix" of youth and experience; cross tabulating all characteristics of product and process material; planning research and test programmes after an inventory of possible failures; indoctrinating engineers in reliability; and establishing a high level quality engineering function.

The last speaker of the first day was Mr. F. G. Willemze who is Chief Industrial Engineer with N.V. Philips in Holland. His subject was "Integrated Control of Product Quality and the Manufacturer" and he set out to put quality in perspective with other considerations such as price, service and advertising policy. In balancing this complex of factors, the leading industrial companies have to take the initiative and accept the risks involved in new developments, without waiting for consumer reactions or standardization recommendations.

TOTAL QUALITY CONTROL

The first paper of the second day was given by Dr. A. V. Feigenbaum of the General Electric Corporation, the President of the American Society for Quality Control, on the subject, "A Total Programme of Quality Control." Coincidentally, on the morning that he gave his paper in Turin, Dr. Feigenbaum's new book, *Total Quality Control*, was published in the USA and in Europe. It is an indication of the powerful emergence of the new concept of total or integrated quality control that a reference and text book, *Quality Control*, written by Dr. Feigenbaum ten years ago—and selling as well in its tenth year as in its first—has been completely withdrawn from sale in favour of his new book.

In his conference paper, Dr. Feigenbaum, a firm believer in the industrial advantages of competition, traced the way in which the free Western economy, as he has seen it develop in the USA, has produced an era of quality competition as much as of price competition. Quality has become of first importance, and progressive American top management no longer tests the efficacy of a quality control programme by "its adequacy as a statistical analysis effort alone" but by "the degree of positive contribution [it] makes to the effectiveness, service and profitability of the total enterprise."

Customer demand for higher quality products has (in the way also brought out in Mr. Brynge's paper) quickly made existing quality control practices and techniques obsolescent and incapable of meeting present day demands. In trying to meet these demands, however, the cost of existing quality practices (inspection, test, laboratory checks, scraps rework and customer complaints) have grown into multi-million dollar dimensions in the USA. Many businesses have quality cost expenditure amounting to up to 12 per cent, and sometimes more, of their total costs. In some cases this is as much as their total direct labour costs.

On the one hand, therefore, industry is faced with the need to improve quality control and, on the other, with the seemingly paradoxical need to cut quality control costs. More and more firms are now coming to appreciate that these two important objectives cannot be attained by concentrating on any one part of the quality control cycle. Instead, they are having to rethink their whole quality control programme in terms of total quality control.

The total quality control approach, said Dr. Feigenbaum, can be most emphatically justified on grounds of cost. He quoted the example of an electrical firm where quality control costs were 9 per cent of overall costs in 1958 but, after the introduction of a total quality control programme, this figure had been cut to 5·9 per cent by the end of 1959. The downward trend continued in 1960 and reached 4·4 per cent. The specific savings made in this case during 1959 and 1960 were: scrap reduced 41 per cent, resulting in a saving of $110,700; rework reduced 48 per cent, a saving of $162,500; complaints reduced 54 per cent, a saving of $31,000; inspection and test costs reduced 39 per cent, a saving of $63,000; and tool maintenance reduced 8·7 per cent, a saving of $22,000. Altogether, this company saved about $400,000 in this two year period and, equally important, the product quality and reliability of motors were much improved. In effect, it made major savings in failure and appraisal costs at the expense of slight increases in prevention costs.

In Dr. Feigenbaum's view, three distinct technologies have evolved in the total quality control field, namely, quality control engineering (assuring product quality and reliability); process control engineering (the technical work that ensures product quality and reliability during production); and quality information equipment engineering (which is concerned with measuring and control apparatus).

STANDARDIZATION

Herr F. Goubeaud, of West Germany, spoke next on "Standardization as a Factor in Integrated Control of Quality." The concept of integrated quality control, he said, calls for even greater standardization of components and procedures. He quoted the setting of fits according to the laws of probability (normal distribution of dimensions) as an example not yet established as standard procedure, but nevertheless already adopted by some leading firms.

He also emphasized that a standardization of terms—particularly of the term "quality" and of those governing procedures for establishing a quality level—is absolutely necessary for the future development of integrated quality control throughout industry. One hopes that this standardization of terminology can be effectively established before the technique becomes so sophisticated that agreement will be difficult, as happened with work study. Already, the Americans talk of total quality control and we of integrated quality control.

The final two papers of the morning of the second day were by M. R. M. de Lorris and M. Pierre Sautet, both of France, and both spoke of the use of integrated quality control in public services. M. R. M. de Lorris, speaking as an Engineer-General of the French Air Force, said that state departments encourage suppliers to use integrated quality control systems. Speaking as an employee of Air France, M. Pierre Sautet described the quality control activities of that airline, ranging over aircraft servicing, operational control, crew control, ground services, survey techniques and customer satisfaction.

CASE STUDIES

In the afternoon there was a marathon session of seven case studies, under the chairmanship of Dr. E. M. Juran, of the USA. Introducing them, Dr. Juran referred to the way in which the growth in size and complexity of industry has multiplied the size and complexity of quality problems. To provide a solution for these new quality problems, he said, requires the mobilization of company resources under the leadership of a recognized coordinating force.

The case studies which were then presented are shown in the conference programme which is given in the Table.

The fifth case study was given by Mr. W. D. Ewan, one of the British delegates, from British Nylon Spinners. He described how cumulative sum techniques have been applied to sampling inspection and process control of continuous processes. He gave examples of schemes used in the nylon manufacturing industry and discussed the practical considerations involved in choosing the most appropriate schemes.

On the last morning of the conference, M. M. Nepper, from Belgium, spoke on "The Place of Research and Development in Integrated Control of Product Quality." His paper underlined the need for research departments to have constant contact with outside sources of information and daily contact with production departments.

Next, Mr. E. H. Ingamells, a British delegate who is quality manager with English Electric Aviation Limited, gave his paper "The Place of Research and Development in the Acheivement of Reliability." Its main theme was concerned with the impact of user handling and environment on life, and was of particular interest because the interdependence of quality control and reliability techniques was a point made several times during discussion on the previous two days.

The last paper of the conference, "The Full Quality Control Cycle," was given by Signor Pietro Larizza, of Italy. He spoke of the need for rational organization of all activity concerned either directly or indirectly with manufacture to yield optimal combinations of production costs, cost of testing, cost of rejects, cost of reworking and costs resulting from the assembly of any defective parts.

FOR THE FUTURE

It was impossible to leave Turin without the knowledge that integrated (or total) quality control is here to stay. The older, fragmented quality control practices are simply inadequate for the needs of modern industry so that, to be even passably efficient, firms will have to tackle the management and technical problems of installing integrated quality control as quickly as possible.

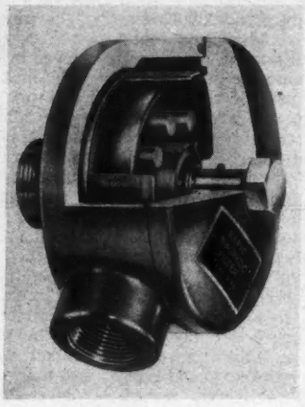
However, now that the concept of overall quality control has been accepted widely enough to ensure its general implementation, the next problem—and, possibly, bone of contention—must be the method of administering integrated quality control. There are differences of opinion about the degree of authority or responsibility which should be vested in a central quality control department at the expense of line management. Whatever solution emerges, it seems likely that it will have a bearing on the whole concept of management for it will be one more indication that the "line and staff" idea is unwieldy and too slow in communications for today's requirements.

It is always difficult to gauge how far a conference is simply a gathering of the converted, but the British delegates were in no doubt that even the unconverted must soon become aware of the advantages of integrated quality control. In this country there is a new agency which is likely to play an important part in propagating the virtues of the new-look quality control.

The National Council for Quality and Reliability, formed last July, is holding its first business meeting in London today, the 29 September. Under the chairmanship of Mr. Frank Nixon—one of the early missionaries and now something of a father-figure among quality control engineers in this country—this council is setting out to coordinate the activities of the corporate bodies and professional institutions which have an interest in quality and reliability. Appropriately, at this stage in the development of the technique, the Council is to be an integrating agent in the field of quality control. In this, it will be working in conjunction with the British Productivity Council which has been this country's contact with the European Organization for Quality Control since that body was founded in 1957.

MAGNETIC PIPELINE FILTER

Sieve Available



EXTRACTION of ferrous and non-ferrous particles of micron size is reported to be possible by the use of the pipeline filter illustrated.

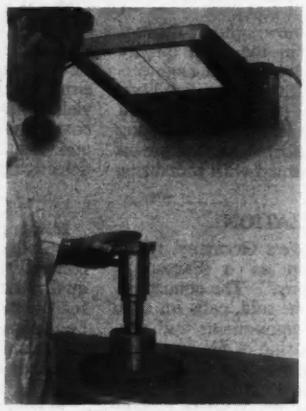
This filter combines magnetic separation with a sieve, but filters are also available with the magnetic feature only for use where ferrous impurities only have to be dealt with. When a sieve is employed this may have a mesh in which the aperture is as small as 0·003 in. Combined magnetic and sieve filters have been applied to machine tools for the filtration of coolants; they are also used for dealing with clay slurries, oils, and other liquids.

The cover of the filter is simply removed by undoing a single screw. The interior is then exposed and the magnets—and sieve if fitted—may be taken out for cleaning. Both types of filter have a body of 7¼ in diameter and a height of 5½ in. Inlet and outlet connections are available in ½ in, ¾ in, and 1 in BSP sizes.

Capacities depend on the contamination and viscosity of the liquids which have to be handled. The maximum throughput is 17·5 gallons per minute and the maximum working pressure 230 lb per sq. in. Weight of the filter with sieve is 7 lb, with magnetic separator alone it is 6·8 lb. *Rapid Magnetic Limited, Lombard Street, Birmingham 12.*

MONOCHROMATIC LIGHT

Measures Flatness



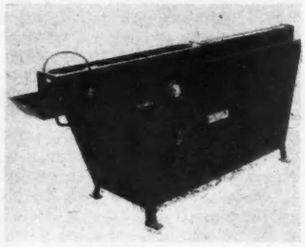
THE new Lapmaster monochromatic light is for checking surface flatness with light band readings.

Compared with previous models the new unit is stated to have several advantages. It weighs less than the original and it may be used on a bench, or fixed to a wall when tall objects require examination; the illustration shows such an application. A high-voltage transformer is incorporated in the headlight. Four helium tubes produce the light, which is diffused through a flashed opal glass cover. The use of four tubes has the advantage that in the event of breakage or failure an individual tube may be bridged from the circuit allowing the unit to be used until a replacement is fitted.

Only one-half of the wavelength of light from the source is used, the increment of measurement being 0·0000116 in. The dark banks visible beneath the optical flat show where interference is produced by reflections from two surfaces. These bands indicate that between the centre of one dark band and the centre of the next dark band there is a difference in level of 0·0000116 in. The surface to be examined must be sufficiently shiny and smooth to reflect light back through the optical flat. *Payne Products International Limited, Buckingham Avenue, Slough, Bucks.*

BROACHING MACHINE

Hydraulically Operated



TO SUPPLEMENT the existing series of hydraulic broaching machines, the 800 range has been introduced. Initially this comprises Model 824 with a 24 in stroke, Model 830 with a 30 in stroke, and Model 840 which has a stroke of 40 in.

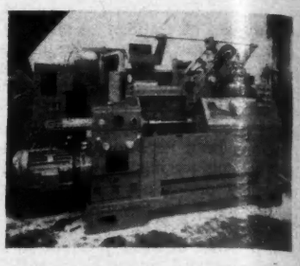
Fabricated construction is used for the frame and base and standard components of normal design are used for the hydraulic circuit. The total pull remains at 2½ tons but the broaching speed is increased to about 5 ft per minute and the automatic quick-return speed to 20 ft per minute. Maximum pressure is set at 700 lb per sq. in. In the case of each model the bore of the hydraulic cylinder is 4 in. Controls have been simplified to eliminate the need for skilled pre-setting. One handle gives push, neutral, and pull movements, and another controls the broaching speed. The pressure required to pull the broach is shown on a large dial gauge. A sealed pre-set safety valve prevents damage through overload.

The machine is supplied complete, requiring only connection to a 440 V, 3-phase, 50 c/s supply. The motor is of 1½ hp. While foundations are recommended they are not considered to be essential.

The height of each model is 3 ft 7 in, the width is 2 ft 4 in. Length of the various models is 5 ft 8 in, 6 ft 2 in, and 7 ft. In every case the centre height from the floor is 3 ft 4 in, and the size of the face plate 8 in by 8 in. All models have a welded oil tank with a capacity of approximately 5 gallons. The broaching head has a standard collet. *Greenbrook Engineering Company Limited, Thompson Street, Padiham, Lancashire.*

PROFILING AND MULTI-TOOL LATHE

Full Equipment



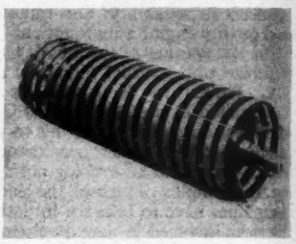
DEVELOPED from the production 8 in model, the Churchill-Redman 816 Model P5 profiling and multi-tool lathe is intended to provide a machine of greater versatility for use where smaller batches of components have to be machined efficiently and economically.

The headstock is fitted with four manually-selected speeds; a 2 : 1 automatic speed change gives eight speed changes in four groups, the range being from 100 to 2,100 rpm. Main drive is from a motor of either 15 or 20 hp. The standard machine is provided with automatic carriage feed change, an in-built coolant system, a hydraulically-operated tailstock with pressure-reducing equipment, and automatic lubrication. Able to swing 16 in diameter, the lathe has a maximum turning diameter of 9½ in and a variation in profiling of 9 in on diameter. Machines are available to accommodate 15 in, 30 in, or 40 in between centres. Push-button control applies to both single or automatic cycle.

A wide range of equipment is available. This includes a 7½ in wide rear infeed toolslide, with hydraulic infinitely-variable feed, which is arranged for automatic operation. A hydraulically-operated vertical infeed slide can also be supplied, and hydraulic chucking equipment with built-in pressure reducing control. Automatic re-cycling can give up to four successive cuts on one carriage. Steadies may be either hand- or hydraulically-operated. Chucking equipment includes a 7½ in diameter three-jaw self-compensating hydraulically-operated chuck and a similarly-operated 9 in diameter three-jaw wedge type unit. *Charles Churchill and Company Limited, Coventry Road, South Yardley, Birmingham 25.*

HELICAL DRUMS

For all Belt Conveyors



FABRICATED helical drums are claimed to be suitable for all industrial uses and particularly applicable to all types of belt conveyors.

These drums are reported to keep the belt centred on the drum face, due to the opposing spirals, formed by the strips, acting against one another when rotating. They are also said to tend to clean the underside of a belt, as to a large extent material clinging to the belt is dislodged by the helicals and, after dropping into the troughs formed by the vanes, falls out of the drum ends. This cleaning action is claimed to prevent damage and undue wear of the conveyor belt.

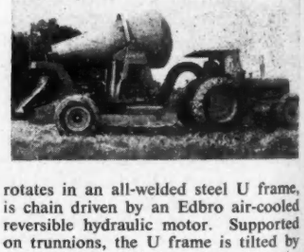
Constructed from welded steel, the drums are said to be practically unbreakable. The face is formed by a pair of steel strips helically wound towards one another with intervals between the convolutions of each. The vanes supporting the face are shaped from rolled steel plate, the thickness of which is proportionate to the required duty. These vanes are welded direct to a shaft in the case of driving drums, or to a tube containing bearings in the case of tension drums.

As no machining of the drum faces is necessary it is reported that the price of these drums is competitive.

These drums can be constructed to within wide size limits to comply with special requirements. The minimum sizes manufactured have a drum diameter of 7⅞ in and a face width of 16½ in. Stock sizes of both tension and driving drums have face widths of 16½, 20½, 24½, 30⅛, and 36½ in. Stock diameters are 7⅞ in and 11⅞ in. *Whittington Engineering Company Limited, New Whittington, Chesterfield, Derbyshire.*

CONCRETE AGITATOR

Tractor Drawn



AVAILABILITY is announced of the Goose concrete agitator. This plant item, an addition to the maker's range of tractor-drawn construction equipment, is powered by a Fordson Super Major diesel tractor. The unit consists of a 3½ cu. yd capacity rotating agitator mounted on a dumper chassis. This chassis has a goose neck and quick-release ball coupling which, it is claimed, gives over 100° articulation on each side. On uneven ground the coupling provides a high degree of flexibility between tractor and trailer. The latter can be detached in 90 seconds. A telescopic hydraulic jack, built into the base of the goose neck, raises and supports the neck when the trailer is detached. Additional stability can be imparted by adjustable legs fitted at each side of the trailer chassis.

Hydraulic power is provided by a pump driven by the tractor engine. The concrete agitator has its own sub-chassis, 2 ft 10 in wide, which is bolted to the trailer chassis. The cone which rotates in an all-welded steel U frame, is chain driven by an Edbro air-cooled reversible hydraulic motor. Supported on trunnions, the U frame is tilted by two hydraulic cylinders pivoted to the sub-chassis. The maximum loading tilt is 65° above the horizontal: the cone discharges at 15° depression into a hopper on the rear frame. Extension pieces can be fitted to the chute to deliver the mix to the spot required. Hopper and chute can be swung through a wide angle to either side of the trailer. The drum rotates at an average speed of 15 rpm.

The length of the complete unit is 24 ft 6 in. That of the cement carrier unit only is 16 ft 3 in, width is 7 ft 9 in, and height in the carrying position 10 ft. The weight is 3 tons. *Mackay Industrial Equipment Limited, Faggs Road, Feltham, Middlesex.*

HEVAC INTERNATIONAL EXHIBITION

Olympia, London, 26 September—6 October

OF a size without precedence in Europe, the first International Heating, Ventilating and Air Conditioning Exhibition was opened on 26 September. The HEVAC Exhibition, as it is styled, has been organized by Industrial Exhibitions Limited, and promoted by an advisory committee from the industry, under the chairmanship of Mr. C. J. Atkins. It is sponsored by the Institution of Heating and Ventilating Engineers.

The many aspects are well represented and include related equipment. Some of the exhibits are illustrated and described on this page.

HOT-WATER BOILER

SOLD under the name of Vauxhall-Golcalor, this new packaged hot-water boiler is basically of Swiss origin. It has been redesigned to comply with British Standards.

A special feature is the provision of preheated combustion air, and the fitting of a small integral circulating pump for preheating the return water. This is said to have the advantage that it makes the unit self contained and independent of system controls during periods of light load. The boiler is a horizontal, 3-pass, shell-type one, with concentric waterways and annular gas passages. It is provided with a burner for 35, 200, or 950 seconds oil.

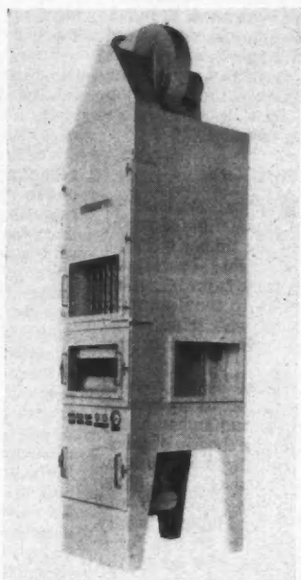
At present the range covers requirements varying from 300,000 to 2,000,000 BTUs per hour. The design is claimed to be suitable for any pressures, where pressurized systems are in use, and to be applicable to any height of building, existing or planned. *Vauxhall Boiler Company Limited, Bondway, London SW8.*

FABRIC DUST COLLECTOR

High Efficiency

WHILE employing limited quantities of compressed air as a cleaning medium, the Dalamatic automatic fabric dust collector embodies the dynamic air-flow characteristics associated with some blow ring type filters.

It is claimed that the Dalamatic filter has virtually 100 per cent efficiency, has low energy requirements, and gives uniform air throughput. An integrated system of fabric filter units enables installations to be assembled which are capable of handling upwards of 100,000 cu. ft per minute. In simple form the collector may consist of one, two, or three tier assemblies, mounted on a hopper, and a silo pressure vessel or conveyor. The illustration shows a two-tier collector integral with fan, hopper, rotary valve, and supports. Contaminated air is entrained into the filter above the filter elements, passes down between the elements, and is filtered into an outlet header running the height of the filter. *Dallow Lambert and Company Limited, Thurmaston, Leicester.*



OIL BURNERS

Low Noise Level

SWISS-DESIGNED Elco oil burners working on the pressure-jet principle, are now available in this country. Capacities range from 60,000 to 12,000,000 BTUs per hour.

It is claimed that these burners are quiet in operation and that those operating on heavy oil have a particularly low noise level. The burners are capable of burning fuel oils from 35 secs to 3,500 secs Redwood No. 1—100° F. Standard types are available for on/off as well as high/low operation. The box-type burners are supplied for modulating operation with a turn-down ratio of 3 : 1. The smaller models in the range are flange-mounted and require no brick base. The larger units are supported by a die-cast foot and tubular steel supports which are adjustable for height on site.

The larger burners are provided with gravity-closed air control dampers, this arrangement having the advantage that the combustion-chamber temperature is not lowered by cold air being introduced during shut-down periods. Elco burners are stated to be suitable for installations where the oil tanks are underground; the pumps produce a maximum vacuum of 24·26 in Hg.

Weights of these burners, constructed from aluminium alloy castings, range from 63 lb to 209 lb. The smaller burners are single stage, larger sizes employ two-stage operation. *Corrie, MacColl and Son Limited, 500 Ipswich Road, Trading Estate, Slough, Bucks.*

MESH FAN

Employs Centrifugal Effect

PRODUCTION will shortly commence of a new type of centrifugal fan.

The construction of the mesh fan is simple, and among the claims made for it are compactness, quiet operation, high efficiency, and lightness. The impeller is formed in mesh, which may be expanded metal, plastic, or other materials. The mesh has the usual pattern of diamond or similarly-shaped openings, and the narrow strands, which during the manufacturing process receive small inclination to the vertical plane, form hundreds of small scooping blades. When rolled into a cylinder the mesh provides a rigid but light centrifugal-type impeller. The whole is assembled in a scroll-shaped housing which collects and directs air as required. In the case of tangential or normal fans, semi-scrolls can be used. Mesh fans are available with both forward and backward curved types of impellers. Due to the fact that the mesh fan has a great number of small blades and small inertia, it is claimed that speed can be increased without appreciable increase in noise. Microsize fans can be constructed for point cooling, examples of such applications are valves or equipment where hot spots present a problem.

Fans with outputs ranging from 25 to 200 cu. ft per min will be available next year but a 4 in diameter fan, with an output of 70 cu. ft per min will be on the market shortly. *Heat Pump and Refrigeration Limited, Lansdowne Lane, Charlton Village, London SE7.*

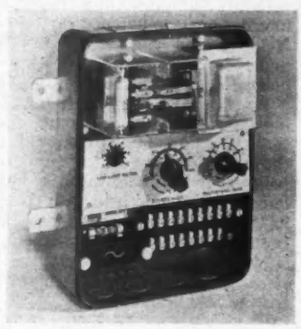
TEMPERATURE CONTROLLER

Proportional

THE Satchwell Monotronic proportioning control system is intended for the automatic control of temperature in heating, ventilating, and air conditioning plants.

The system is claimed to fill the demand for a simple single-stage controller. Typical applications are the local control of temperature from a heater battery and similar duties, particularly where the expected load changes and system lags are small. It provides a complementary control to the Duotronic two-term controller (proportional plus integral) which is used for more complex schemes.

Using a transistor amplifier to increase the signal due to temperature change, the Monotronic system provides proportional correcting action. The circuit is reported to be very sensitive and able quickly to detect and respond to any deviation in temperature from the desired value. A basic set of controls comprises a temperature detector, a controller, illustrated, and a valve- or damper-operating motor. The detector is located in the space or medium the temperature of which is to be controlled. There are no moving parts, the thermal element consisting of a small coil of temperature-sensitive resistance wire. When the control temperature deviates from the desired value the resistance of the thermal element alters and a signal, proportional to the deviation, is fed to the controller. The electronic circuit provides correcting action. *The Rheostatic Company Limited, Slough, Bucks.*



AIR-CONDITIONER

Economic and Self-Contained

THE Frescon air conditioner is reported to be able to maintain conditions steady for indefinite periods without attention.

In its standard form the plant is claimed to be a versatile unit, which is simple, efficient, and a highly economical means of limiting relative humidity and temperature. Available as a compact, self-contained, packaged plant it is said to have a wide range of applications. The unit is contained in a sheet-steel cabinet, divided into lower, middle, and upper sections. Air is drawn in through the middle section and passed through a refrigerated element before being discharged back through the top section. Excess moisture is condensed as it passes through the refrigerated element and is drained from a drip tray.

All necessary electrical equipment, including a main isolator switch and automatic starters for the compressors and fan motors, is built into the cabinet. A regulating valve is provided to conserve the cooling water supply to the condenser. Six sizes are available with capacities from 1,200 to 8,000 cu. ft per minute. *AEI-Birlec Limited, Tyburn Road, Erdington, Birmingham 24.*

Killing the Prejudice Against Timber

Timber is still the Cinderella of the structural materials in Britain. For wider use, the old craft trade must adapt itself to quality control and the production of standard structural components.

THERE has been a steady growth in the use of timber as a structural engineering material in the United Kingdom over the last twelve years. Nevertheless, there is still a fairly wide resistance to its use except for the traditional one in housing. Timber is very much the poor relation to steel and reinforced concrete, and one very significant reason for this is the absence of teaching in timber technology from university and technical college courses.

The Timber Development Association have done a great deal to sponsor the proper use of timber and to build up a body of scientific knowledge concerning its properties. Last week (18 to 23 September), the TDA in conjunction with Southampton University sponsored the first international conference on timber engineering. Held in the engineering department of the university, the conference attracted nearly 150 delegates, including 36 from 14 countries overseas.

Professor P. B. Morice, the dean of the engineering faculty, in his welcoming address, observed that the conference had been arranged to match those enjoyed by other industries and it was believed that it was the first international conference ever to be held with structural timber as its theme. To limit the scope of the papers it had been decided that roof construction should be the subject for the conference; he intimated that stress grading had been suggested as the subject for the next conference.

AGAINST TIMBER

Altogether 20 papers were presented for discussion in six sessions: general problems of timber construction; structural timber joints; shells; some particular types of structure; tests and failures; and economics and comparisons. Complementary to the discussions—each session was introduced by a general reporter and followed by contributions from the floor and then replies from the authors—there was an exhibition arranged by the TDA and some of their member firms, and a number of visits to sites in southern England where timber roofs were to be seen.

The first paper on the programme set the theme for the whole conference. It was entitled "The Prejudice against Structural Timber" and was contributed by Mr. R. J. M. Sutherland of A. J. and J. D. Harris, consulting engineers of London. The succeeding papers were all a refutation of the criticisms levelled against timber as a structural material—solid evidence of experiment and practice, though evidently much still remains to be done.

Mr. Sutherland began his paper by outlining the prejudices he found against structural timber as opposed to its acceptance as cladding, for doors and windows, and other traditional joinery. The prospective owner thought of timber as a temporary building material that was combustible; at best he saw it as a fancy cricket pavilion and, at worst, shabby hutting. The architect was prepared to use "wood" on a small scale but when he had a large job he turned to steel and concrete.

The engineer to-day, especially the younger one, regarded timber as beneath him—steelwork was all right, reinforced concrete was proper engineering and prestressed concrete was positively holy; but timber, that was the stuff for joiners.

And, at the other end of the scale, Mr. Sutherland found the general contractor, who thought of timber only in terms of traditional carpentry carried out by craftsmen who were in short supply and who had to be treated with some respect.

Most timber engineering, if not carried out in orthodox joinery works, was done by small firms, often as backyard businesses. Few firms ever grew out of this shape: the present demand for advanced timber structures was at best uncertain, qualified designers hardly existed, and the craftsmen who formed the backbone of such firms were by nature as adverse to new technicians as they were to new techniques.

The designer too had his difficulties. He was abysmally ignorant of its properties. Most engineering materials were isotropic and were fairly consistent in character. Not so with timber. There were some established design techniques but the material was so variable that these had to be extremely conservative; deflections tended to be very important and the material might split, twist, shrink or creep. Moisture contents mattered, especially with glued joints, and then there were all the bogies of beetle and rot.

The craftsman was accustomed to taking precautions against these shortcomings of his material and most of the traditional methods of jointing timber were devised with these in mind. He considered the designer ignorant and would put in the "proper joints" himself; at best this was a waste of effort but it might also weaken the structure. There was probably less attention paid to specifications and drawings with timber than any other engineering material.

OUT-OF-DATE CODES

This disregard of the accepted methods of communication Mr. Sutherland attributed to the survival of the craftsmen of the timber world, a survival which, for all its admirable aspects, was holding timber engineering back from becoming a technology. As one speaker to the discussion put it, a common language was required to bridge the gap between architect, engineer and builder.

Other speakers blamed an out-of-date code of practice for the lag in the widespread acceptance of timber and, throughout the conference, many questions were asked concerning the life of glues. The tests required today, and the specifications, were only concerned with the strength of a glued joint a short time after it was made. Would glued joints be sound after ten, fifteen, twenty years or more? Timber could be treated for it to have a high fire resistance, but could the adhesives? Much more information was obviously required on these points. The new code of practice is in the course of preparation and will be far more comprehensive than the one it replaces.

Among the remedies which were put forward by the author were stress grading by the timber merchants and quality control by the manufacturer. Stress grading was available in other countries and it was needed in Britain. The timber should be selected by trained people and marked to show that it satisfied the grading rules of BS 1860 for, say, Group I or Group II timbers; such trade markings as "select merchantable" were of very little use. The cement and steel industries provided certificates of the worthiness of their branded products, why not the timber trades?

There was also a need by designers for data on the sizes, groups and grades readily available, together with approximate costs, thereby paralleling the steel industry's section book. It was suggested during the discussion that, as the designer was necessarily working several months in advance of the manufacturer or builder, such data as the suppliers could currently quote could not be of value to him. It would seem however that if the timber industry is going to compete successfully with other structural materials, the designer has got to know what timber sections he can employ with advantage, and it will be up to the industry to adapt their product to match their competitors'.

For quality control, Mr. Sutherland wanted something akin to what the concrete industry had done during the last ten or 15 years. Such practices in timber manufacture would be the clearest sign that timber had changed from the craft stage to the technological stage. Quality control implied work carried out indoors at stable and known moisture contents; accurate preparation of surfaces for gluing and a real understanding of glue types; also preservatives applied with certainty, routine testing of shear strengths of glued joints and chemical tests or impregnation, possibly by independent laboratories as in the case of concrete test cubes.

There was also a need for standard built-up sections corresponding to the rolled steel sections or the standard precast concrete bridge beam. These would probably be rectangular and composed of three or more laminates with staggered scarf joints, available in varying lengths, and members of 40 ft or more in length would be obtainable as a matter of course. Such standard sections would be used either on their own or built up by further fabrication—either in the shops or at the site—into more complex forms.

This broad review of the place timber has in the British constructional field set the pattern for the discussions during the rest of the conference, the papers serving to bring out the points of detail. There was, however, a noticeable distinction between the papers according to their geographical source. Thus the two papers from North America, where timber is a significantly more important and more economic structural material than in Britain, were reports on the way timber is used, and this approach was to some extent also followed in the paper from India. In contrast to this practical approach was the theoretical treatment that predominated throughout the papers from the European countries, where a lot of fairly complex investigations have been undertaken in attempts to analyse the strength of timber joints. The British papers, which formed the largest number of the contributions, spanned between these two extremes, a single paper frequently considering both fundamental ideas as well as economic and practical topics, a situation which reflects the current state of timber technology in the country.

NORTH AMERICAN PRACTICES

Both in Canada and in the United States, the relative position of timber with respect to reinforced concrete is much stronger than in Europe. To take only one example, glued laminated girders are frequently used for road bridges, whereas over here they are unheard of for such an application. With the readily available forests there, this situation is understandable and, in consequence, the standards and practices are more highly developed, both in regard to gluing and in the use of mechanical fixings.

The Canadian paper, by Mr. R. F. Degrace of the Canadian Institute of Timber Construction, was concerned with laminated roof structures. Although conditions for roof construction vary across the country, there has been a quite general gain in popularity of laminated wood, especially in the form having solid rectangular cross-sections. These sections are admittedly inefficient so far as the use of material is concerned, but they have continued to be used because of the relatively low cost of the material compared with the cost of manufacturing and of construction labour.

In recent years more sophisticated forms have been introduced into Canada, having greater theoretical efficiency. These new techniques include the Swedish HB method that uses laminated in combination with sawn timber, plywood folded plates—there were questions

about the small use of plywood in Britain, and a plea that its cost should be cut—stressed skin panels, and plate and barrel arches employing plywood skins. All these applications involve the use of structural laminated timber either as an integral part of the member or as part of the supporting structure. Greater use is also being made of such devices as continuous and cantilevered beams to obtain economy.

CANADIAN CODES

Structural design of laminated wood is generally controlled in Canada by the "Code of Recommended Practice for Engineering Design in Timber," published by the Canadian Standards Association; and most building work comes under the jurisdiction of the National Building Code of Canada, developed by the National Research Council. By careful correlation the recommendations for wood construction issued by these two bodies have been made identical in technical content.

The resulting design codes provide data on the physical properties necessary for the structural design of each of the four "strength grades" of laminated wood. They do not, however, attempt to detail how these strength grades are to be obtained in manufacture, either as to the grades of laminating stock to be used or the manufacturing process to be employed. Manufacture is covered by a separate CSA specification, "Glued Laminated Softwood Structural Timber," which is coordinated with the design codes so that material produced under its requirements always amply satisfy the needs of the designer.

The manufacturing specification provides for three kinds of grades: service grades, appearance grades and strength grades. Service grades are distinguished mainly by the type of adhesive: "exterior grade" uses fully waterproof synthetic resins and "interior grade" permits water-resistant adhesives such as caseins and urea-formaldehyde resins.

There are three appearance grades, differing only in the character of the surfaces exposed to view. Quality appearance grade is for use for a transparent finish such as varnish. The paint appearance grade presents an uninterrupted surface, but permits colour variations that can be hidden below an opaque coat. The third grade, industrial appearance, is usually left unpainted and is for those locations where appearance is of no significance. All the appearance grades are independent of both strength and service grades.

Strength grades are controlled by the strength qualities of the laminations themselves, and by the manner in which they are assembled in the member. There are four grades, one being most efficient in bending, two in compression, and the fourth in tension. The requirements for these four grades were determined as a result of studies of knot frequency and scarf joint strength, coupled with statistical methods developed from research carried out at the Forest Products Research Laboratory, Madison, USA.

The CSA manufacturing specification details the manufacturing requirements for each strength, appearance and service grade, but it does not attempt to specify details of quality control. This is done by the Canadian Institute of Timber Construction's "Qualification Code" which was established in 1958 and is now the only system of certification available in the country for this purpose. The code requires certified manufacturers to conform to detailed standards for production and quality control, equipment procedures, manufacturing methods and key personnel. The Institute enforces continued conformance by initial and repeated examination at unannounced intervals. Three classes of work are provided for: class I, for interior grades; II, for exterior grade softwoods; and III, for exterior grade hardwoods.

Since the establishment of the CITC system of quality control and certification, no failure or distress has been found in a building provided by certified manufacturers, though there have been a number of disasters among structures erected during the period when the laminating industry was getting underway. Quite a large proportion of the discussion throughout the conference turned on the possibility of a structural failure; the general experience (though there have not been many failures) being that it was more likely to be the glue line which failed in practice, rather than the timber, even though relatively poor quality material may have been used. It was reported by Mr. Hugh Tottenham, who has probably had as much experience of designing shells as anyone in Britain, that there had been a marked increase in the failure of concrete shells of recent times. This he attributed to the mis-use of certain simplified methods of designing shells and he strongly advocated the continued dependence on the more elaborate systems of analysis that had been derived.

AMERICAN TRUSSED RAFTERS

In contrast to the Canadian paper on glulam components, that from the United States dealt with short-span (less than 40 ft) trussed rafters using nailed or other mechanical connections usually without glue. The author of the paper, Professor E. George Stern, from the department of wood construction, Virginia Polytechnic Institute, described trussed rafters as the outstanding development in the last decade in the field of building construction. He said they had become the most popular building component in North America, being the most economical way of supporting the roofs as well as the ceilings of small and medium-sized structures, including houses, schools, industrial and farm buildings.

Made from nominal 2 in lumber, the trusses are lightweight components that are commonly used at 2 ft spacings, though for heavier loadings the spacing can be decreased to 1 ft or, in the case of farm or industrial buildings, where no ceilings are required, the trussed rafters can be put up at 5 ft centres. Side slopes can vary from 2 in 12 to 6 in 12. Though commonly made as W, scissor or kingpost type trusses for building widths of 18 ft to 40 ft, multiple kingpost trussed rafters of 60 ft span and for 120 ft wide buildings are also available.

The early trussed rafters, developed less than fifteen years ago, were designed for assembly with 2½ in split-ring connectors and ½ in bolts provided with washers at both ends. The rings were inserted into pre-formed grooves and the holes for the bolts were pre-drilled oversize. In this arrangement the connectors transmitted all the forces and the bolts kept the members from spreading apart. To eliminate the need for special fasteners and tools, nail-glued trussed rafters were designed, requiring the use of plywood gusset and splice plates.

In contrast to earlier split-ring connectored trusses, both the all-nailed and the nail-glued trusses have the primary members in the same single plane. While the all-nailed trussed rafters can be assembled using a simple jig either in a yard or at the site, the nailed-glued trussed rafters are a plant product requiring assembly under carefully controlled conditions. A more recent development is the rafter made with sheet-metal gusset and splice plates and it was remarkable to observe from Professor Stern's paper the variety of these sheet metal connectors available in the United States. As one speaker put it, it was now hard to drive a nail without infringing someone's patent.

Some of the metal sheet plates are suitable for site or yard assembly by joiners but the bulk of the patterns are intended for high speed shop assembly, and examples are to be found of plants able to turn out hundreds of these trussed rafters in a day.

The steel gusset and splice plates that are commercially available in the United States can be grouped into six types: (1) plain flat plates inserted into saw kerfs of the lumber; (2) pre-punched flat or dimpled plates nailed to both sides of the lumber; (3) pre-punched plates with protruding prongs of various designs, fixed by the prongs with or without supplementary nailing; (4) pre-punched plates with protruding teeth which penetrate well into the timber; (5) punched plates with self nails and (6) pre-punched and pre-bent plates. The flat, bent and pronged plates are made of 20 gauge hot-galvanized cold-rolled steel. Those plates that incorporate nail-like teeth are made of heavier 18 or 14 gauge steel. To speed the work where nailing is required, large diameter bright low-carbon steel or hardened high-carbon steel nails, helically threaded, have been used satisfactorily.

More than one speaker made the point that the common wire nail was not an engineering component and that it was no use attempting to make an engineering joint with it.

A considerable amount of space in this report has been devoted to these American trussed rafters because they represent a very basic timber engineering component. Architects may well appreciate some of the exotic roof forms that are currently fashionable in some quarters, but the fact remains that a large part of industry, from whom any large scale expansion in structural timber demand must come, is more likely to prefer down-to-earth conventional designs. There will be more good business in timber trusses, rectangular glulam sections and plywood box-beams (if the price of plywood comes down) than in more "advanced" structures.

SHELLS AND ECONOMICS

Many speakers pointed out shell construction was work for the specialist at site, but at least one contributor to the discussions suggested that the builder at site should be a general contractor and that he should buy the shells out just as he bought doors, windows and any other components. The same speaker drew attention to at least one shell that had been dismantled on several occasions and shifted about the country before re-erection, apparently without suffering any damage.

Fire risk in shells was not thought to be great as long as adequate protection could be given to the metal ties—encasing them in wood was one suggestion. An example was also quoted of one shell that suffered partial damage in a fire but was successfully repaired though it was believed that other roof forms might not have survived at all. Yet another case of shell versatility quoted concerned a roof for which one support settled 18 in (due to adjacent works) without obvious damage to the shell.

In many ways the two final papers were the most important of the conference, for both considered timber in competition with other materials. Professor Morice and Mr. Annette, both of Southampton University, outlined briefly the use of computers for structural analysis. In particular, they suggested how such a machine might be applied to timber designs to effect the most economical arrangement and a computer programme was outlined for the design of timber box frames. They also indicated how the computer could be employed to produce relationships between cost and structural shape, and some hypothetical costs were worked out for differing spacings and spans of beams and frames.

The other paper given during the final session was contributed by Professor A. W. Hendry and John Cooper, both of the department of building science at the University of Liverpool. The paper summarized the results of a comparative study of single storey timber buildings capable of covering a clear ground floor area of 2,000 sq. ft. Beams, portals trusses and a variety of shell forms were considered under three broad headings primary architectural considerations such as functional and aesthetic suitability; technical factors, such as ease of erection, durability, thermal resistance and fire resistance; and finally questions of relative costs were considered.

On several occasions during the conference, reference was made to the possibility of establishing an international secretariat for clearing timber engineering developments and, indeed, more than one firm offer was made to initiate a suitable organization. It is to be hoped that this will be done.

The Timber Development Association are arranging to prepare bound volumes of the proceedings, including the discussions, to be ready sometime next year.

Keeping the Army Supplied with Fuel

More than 10,000 gallons of petrol alone are required to move one armoured regiment a distance of 50 miles, and it is therefore essential than an effective fighting force has abundant supplies to draw on when required.

Detachments of the Royal Engineers have recently utilized the resources of No. 1 Petroleum Reserve Depot, RASC, West Moors, Wimborne, Dorset, for the purposes of exercise " Go-Devil," an ambitious undertaking designed to test the ability of the men to build and operate a bulk petroleum installation capable of maintaining a sizeable force in the field. As is the case with most military operations, speed in erection was an essential requirement and most of the equipment used was designed with this in mind.

The centre piece of the installation was the storage and pumping station, shown in the illustration. Storage was provided by three steel tanks of 350,000, 105,000 and 17,500 gallons capacity. All these tanks were portable, being fabricated from steel sheets bolted together, the largest requiring 17,000 bolts. Joints were made leak-proof by the use of Neoprene strips as gaskets, but it was found advisable to apply the final tightening to each bolt with a torque wrench to ensure correct tension and facilitate the lining up of succeeding holes as the work progressed.

The pumping station comprised four Morrison pump units each consisting of a five-stage screw-type pump driven by a six-cylinder Dorman diesel engine.

In all, nine miles of pipeline were used and, for the purposes of the exercise, the fuel was pumped round in a circle. The pipes themselves were of aluminium and of a type first used only last year. They were joined together using a rubber sealing ring and a split collar. The time taken to make these joints was only about two minutes, a considerable saving on the time taken to weld the steel pipes used in the corresponding civilian installation. Apart from a few special shaped steel sections, there appeared to be no welding anywhere in the system—an important feature for a military enterprise where time is at a premium and provision must be made for the replacement of sections damaged by the enemy.

Though the area was flat, a number of natural hazards for the pipeline were simulated and various machines used to overcome them. One was a machine that forced a hole under the obstacle through which the pipe was subsequently laid. For inaccessible areas, the lightweight aluminium pipes are ideal for aerial transport and a Westland Whirlwind helicopter made light work of bundles of eight pipes, though its capacity was only 800 lb.

Extensions to BOAC Aprons at Heathrow

To provide extra space for British Overseas Airways Corporation's Britannia, Comet, Boeing and other fleets, in addition to its requirements for Vickers VC10 aircraft, 55,000 sq. yd of new high strength aprons (and 11,000 sq. yd of service vehicle pavement) are being constructed at London's Heathrow airport for the Corporation by George Wimpey and Company Limited. The contract also includes the formation of an earth embankment 30 ft high, 100 ft wide and 1,800 ft in length, to shield the local residents from engine noise; alongside other areas precast concrete blast screens have been erected to deflect the jet exhausts upwards. Twelve extra stands for aircraft are being provided, six of which have been used for passenger handling during the 1961 summer peak period; all twelve will ultimately be used for aircraft maintenance.

Some 25,000 cu. yd of high quality concrete are required for the aprons, the pavement area concrete having been designed to attain a minimum strength at 28 days of 5,000 lb per sq. in. For the twelve aircraft stands the concrete is being laid 14 in thick in one layer on top of a 4 in thickness of dry lean mix, with a polythene membrane between the two layers. Lower strength areas for servicing vehicles are being laid 6 in thick with BRC reinforcing fabric on a 4 in dry lean mix base. To differentiate between the aircraft and other pavements, the latter are being darkened with Witco " Gatwick Black."

To cater for any creep tendency, a double expansion joint, provided with an abutment, is used at approximately 120 ft intervals,instead of the $\frac{3}{4}$ in or 1 in gap, which is more normally used without support at 100 ft intervals. Lindite, a proprietory polyeurethane, is being used for the jointing material. Proving tests showed excellent resistance to kerosene petrol and oil spillage, thermal effects and jet blast. The edges of the low strength areas are marked out with epoxy resin paint, this being virtually indestructible by skidding, petrol and synthetic oil.

Both the high strength and lean mixes are prepared on site with a Blaw Knox AP 100 concrete mixing plant, consisting of two stationary pan " Gyramixers " of 28 cu. ft mixed batch capacity. The Gyramixers deliver to a skid-mounted conveyor and a 4 cu. yd receiving hopper. Batch time is 20 to 30 sec, each Gyramixer having an output of 60 cu. yd per hr. Adjacent to it are portable, extendable bulk cement handling units. The plant is pneumatically operated, hand operated valves controlling the operation of aggregate bin gates, the weigh hopper discharge gate, the cement silo discharge valve and the cement weigher discharge, the mixer discharge and wet concrete hopper discharge. The water feed supply to the mixers is pressurized and has a pneumatically operated discharge, the amount being measured volumetrically by means of an adjustable syphon, which is set by a gauge calibrated in pounds and gallons. The compressed air for the operation of the pneumatic equipment is obtained from a Consolidated Pneumatic rotary Power Vane compressor. Mixed concrete is carried by Thames Traders fitted with 3-way tipping bodies fabricated in the contractor's workshops. A concrete laboratory is maintained on site, cubes being specified at the rate of three every 150 cu. yd, though cubes are being taken at more frequent intervals.

The apron construction, and also the noise-reducing works, are being carried out for BOAC by George Wimpey and Company Limited, Southall, Middlesex. The consulting engineers are Frederick Snow and Partners, London, who were responsible for Gatwick Airport.

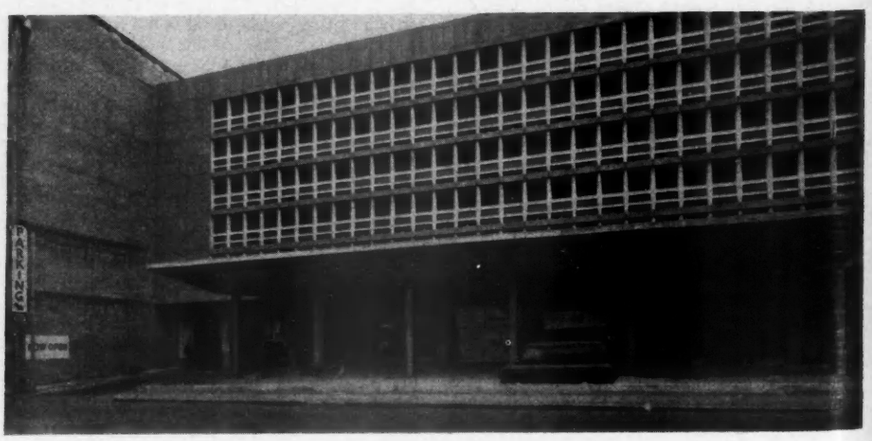
Reducing the Fire Hazard in a Multi-Storey Garage

By using open walls—no windows—in the Aldersgate garage, the City of London's first multi-storey car park, it has been possible to satisfy the fire regulations without having to install either mechanical ventilation or sprinkler systems.

The garage can accommodate 700 vehicles on eleven half-floors connected by cross ramps. There is also a space for commercial vehicles and large private cars in the basement, which has a four hour fire resistance and where a sprinkler system and mechanical ventilation has been installed.

Cars enter and leave past a single check point and drive to the back of the building where the main ramps lead up to the first half-floor level and down to the basement. From the first half-floor level upwards, the half-floors are in staggered tiers with an effective width of 53 ft—the minimum distance in which two lines of cars can be parked leaving adequate driving and manoeuvring space between. Floor levels are connected by two short 14 ft wide ramps of 1 : 9·4 slope.

The design of the structure was based on the maximum use of precast units so as to reduce site work and to make full use of concrete works owned by the Fram Group, the company who built it. The group comprises the Russel Building and Contracting Company Limited and the Fram Reinforced Concrete Company Limited, both of Manchester, and the Vibrated Concrete Construction Company Limited, of London.



Companies

The Confidence of George Cohen 600

AFTER the 11 per cent fall in their pre-tax profits for 1960-61, which was announced in the preliminary profits statement of the GEORGE COHEN 600 GROUP LIMITED, many people will find a number of quite reassuring features in the chairman's review last Wednesday.

Mr. Cyril M. Cohen acknowledges that the reduction in the profits of the year, from £1,573,000 to £1,400,000, is "most unwelcome," but points out that that result was certainly more than could reasonably have been foreseen in November, 1960, when the group made their rights issue of shares.

The losses seem to have been mainly in connection with certain of the group's overseas companies. A substantial part of these, Mr. Cohen affirms, could only be evaluated, with some accuracy, in the last quarter of the financial year. They were incurred owing to a combination of circumstances which arose from contracts being broken by a few large overseas customers, and the difficult commercial, economic and political conditions which prevailed. Prompt remedial action was taken.

Nonetheless, there were several bright aspects to the group's overseas activities. They purchased the whole of the plant of the Uruwira Mine, Tanganyika, which had to shut down because the ore ran out prematurely. The plant, which is very modern and in excellent condition, is selling well. The group are also in the process of dismantling ore plant which they bought in Sierra Leone. Their subsidiaries are, in fact, willing to undertake any work of this type, however difficult or geographically remote.

The group's disappointments in the civil and structural engineering fields at home were akin to those which were experienced by other concerns similarly engaged. These setbacks marred the very real successes which the group made with their other businesses.

Success in Many Spheres

Profits from the George Cohen 600 Group's machine tool and steel stockholding activities were substantially improved. Mr. Cohen also reports satisfactory results from the group's home-based merchanting businesses and from their subsidiary firms K. AND L. STEELFOUNDERS AND ENGINEERS LIMITED and G. BEATON AND SON LIMITED.

K. and L. Steelfounders were fully occupied during the year but the available production facilities could not be used to their maximum advantage because, like many other concerns, they suffered from a shortage of labour, particularly skilled labour. In spite of this handicap, their overall output increased.

Due to the expansion of the commercial and public vehicle side of the Beaton company's activities, that firm's profits "were admirable." Their results justified the confidence placed in them that they would make a significant contribution to the group's earnings.

The SELSON MACHINE TOOL COMPANY LIMITED, another subsidiary, supplied a wide range of new machine tools, of advanced types, to many of this country's leading engineering concerns.

As to the group's outlook in the immediate future, the situation generally has been changed by the measures recently announced by the Chancellor of the Exchequer, and Mr. Cohen feels that it would be unwise at this stage to make any positive prediction about trading prospects for the present year. But for the Chancellor, he had intended to survey the outlook optimistically. As it is, he feels that it is, as yet, far too early to assess the probable effects of existing Government action and of any further steps that may be taken in a possible autumn Budget.

Piping Prosperity to Holland

Next year Europort, the great seaward extension of the port of Rotterdam, will come into operation. Although the new installations will cover a wide range of products and activities, one product, oil, will overtop the rest in importance. Two recent events point the way to future developments. These are the completion of the new 4½ million ton Esso refinery and of the 300 km 24 in crude oil pipeline from Rotterdam to the Ruhr.

The new Europort docks will be able to handle tankers of 65,000 tons. Eventually they will be able to take tankers up to 100,000 tons. At present Rotterdam cannot accommodate tankers of over 50,000 tons. The annual capacity of the three refineries in the Pernis-Botlek area of Rotterdam harbour is about 23 million tons. This will shortly rise to 25 million tons when the capacity of the CALTEX refinery is increased by a further 2½ million tons. Europe's biggest refinery is the 16 million ton ROYAL DUTCH/SHELL, which has petrochemical plants capable of producing 15,000 tons of synthetic glycerine and 50,000 tons of rubber a year. Royal Dutch/Shell, Esso and Caltex are all building big terminal facilities at Europort which will be linked by pipeline with their refineries. Most of the crude oil now coming into Rotterdam is from the Middle East with some other supplies from the Caribbean.

The Esso refinery will eventually take some supplies from the Jersey-Standard Oil group field in Libya. All this activity in the oil industry is a part of the policy of industrialisation now being followed by the Dutch Government. With a rapidly expanding population in a confined area swift action was called for. In the ten years up to 1959 there has been a 75 per cent increase in industrial production. Several new industrial developments outside the oil industry are centred on Europort. One is for an integrated steel plant receiving all its raw materials by water as does the Hoogovens Plant farther up the coast at Ijmuiden. In one important respect the Netherlands have a newfound advantage over their neighbours in Belgium and Germany. This is that not being a major coal producer Holland is not now embarrassed by mountainous pit head stocks. With a home production of only about 12 million tons a year it has not been difficult to reduce consumption in favour of oil. In fact, the Dutch coal industry is reported to be in good heart as last year the State coal mines and private colliery owners alike all made profits.

BSA Form New Holding Company

Ten companies which were previously included in the BSA tools division have now been formed into a new holding company, to be known as BSA TOOLS GROUP LIMITED. All ten firms are subsidiaries of the BIRMINGHAM SMALL ARMS COMPANY LIMITED.

The object of this change in the status of the group's tools division is to facilitate its administration, in view of the division's widening activities and expanding volume of business. Mr. Eric Turner is to be the chairman of BSA Tools Group, with Mr. S. A. Roberts as the managing director. Mr. Roberts will also be the chairman and managing director of eight of the ten subsidiary firms. Mr. Turner, who is chairman of the parent Birmingham Small Arms Company, will be a member of the boards of these eight subsidiaries, as well as chairman of the CHURCHILL MACHINE TOOL COMPANY. Mr. Roberts will be deputy chairman of Churchill's. The address of BSA Tools Group is Mackadown Lane, Kitts Green, Birmingham. The offices of the parent company are at Small Heath, Birmingham.

Working for the Underground railways. Contracts for the disposal of some of London's tube trains have been awarded to the George Cohen 600 Group.

State Assistance Sought For Borgward Car Firm

In direct contrast to the rising fortunes of the Volkswagen concern at Wolfsburg, the Bremen motor firm of Borgward is in the kind of difficulty that has led to its proposal to form a new company with the assistance, to the extent of £4 million, of the Bremen authorities.

Employing almost a quarter of the Bremen labour force, the success or otherwise of the firm, which is a family business, is of more than usual importance to the city. Exporting its cars to all the major world markets, Borgward last year had a turnover of some £50 million.

Plans for a more unified organization with certain other firms, including a number of components manufacturers, have been discussed for some time past and consideration of the scheme is continuing.

It has been said that if the plan to form a joint concern with the State falls through, up to 20,000 Borgward workers will be dismissed. An official of the company has said that it is planned to dismiss some workers or to put them on short time; meanwhile the wages of the workers are "in no danger."

Visco Simplify Their Name

Incorporated in 1921, the Visco Engineering Company Limited have now changed their name to VISCO LIMITED.

As previously, the firm will continue to manufacture their ranges of air filtration, fume removal, dust collection water cooling and industrial ventilating equipment, as well as their specialized items such as the Visco isokinetic fume sampling apparatus (VISA) which they recently placed on the market. The firm's factories are at Stafford Road, Croydon, and at Port Causeway, Bromborough, Cheshire.

Thornycroft's Yachts and Small Craft

More and more overseas markets are taking to building their own small ships. To meet this tendency and the changing pattern of the yacht and specialized boat market in the United Kingdom, a number of innovations are being made in the shipping side of their organization by JOHN I. THORNYCROFT AND COMPANY LIMITED.

For example, while continuing to design and build new craft for home and export, their subsidiary firm, THORNYCROFT (HAMPTON) BOATYARD LIMITED, will be enlarging their mooring, laying-up and repair facilities at their Thames island shipyard, near Hampton Court. The yard will act as agents for proprietary small craft, marine engines, outboard motors and ship chandlery. Mr. D. F. Gilmour, A.R.I.N.A., is succeeding Mr. H. Bish as the yard manager and has been appointed a director of the subsidiary concern.

The parent organization are offering a technical advisory service which is prepared to provide technical services to overseas shipyards, based on the company's long experience in many countries. The establishment of a brokerage section for the sale of commercial craft is under consideration.

A Chemical for Controlling Water Slimes

Many slimes and bad egg smells can be cured or avoided with an inexpensive chemical additive called Panacide. Several users of this product relate how their troubles were overcome.

IN INDUSTRIAL water systems, such as cooling systems, air conditioning plant, and refrigeration plant, slimes frequently coat the plant, causing blockages of pipes, condenser tubes, spray nozzles and valves. The slime results in a loss of operating efficiency, reduction of heat exchange capacity, corrosion and bad odours.

These slime growths are usually due to bacteria, fungi or algae, and the variety of these micro-organisms is such that many can grow under surprisingly unlikely conditions. For reasons of economy, the great majority of industrial systems recirculate the used water. This provides excellent conditions for microbiological growths, since the sources of food are enriched by concentration in the circulating water.

Bacterial slimes may be grey-white, yellow, orange-brown or even black in colour. ("Bad egg" smells are often associated with black slimes.) Fungi usually contribute to slimes only in conjunction with bacteria. On the other hand, algal slimes are green in appearance and will only grow in the presence of light.

Many water systems are kept going only because they are given mechanical cleaning during regular shut-down periods, or during costly stoppages in production. Often the best that is done is a thorough cleansing of only the more accessible parts of the system, with the result that slime rapidly reappears in the system due to reinfection from the uncleaned parts.

Clearly, this procedure does not eliminate the source of the trouble, but merely attempts to keep the nuisance at an acceptable level.

The best answer to slime problems will be low in cost, safe, non-corrosive, and effective against a wide range of organisms throughout the entire water system whilst avoiding substantial labour costs.

Panacide, a product of British Drug Houses, is claimed by the makers to fulfil these requirements. Already widely used in the paper and gas industries and in textiles, Panacide is believed to mark a significant step forward in industrial water treatment.

This chemical is sold as a prepared solution which is simply poured into the contaminated circulating water at any convenient point. Dispersion throughout the system is rapid and the attack on micro-organisms in all parts of the system is soon effective.

The makers say that Panacide is highly active against algae, fungi and bacteria: its action is so rapid that in heavily contaminated equipment the accumulated slime often begins to fall from surfaces within a few hours.

The dose must be regulated according to the degree of contamination and the conditions under which the given water system operates. For this reason BDH provide a technical service to advise on initial treatment and subsequent maintenance dosage.

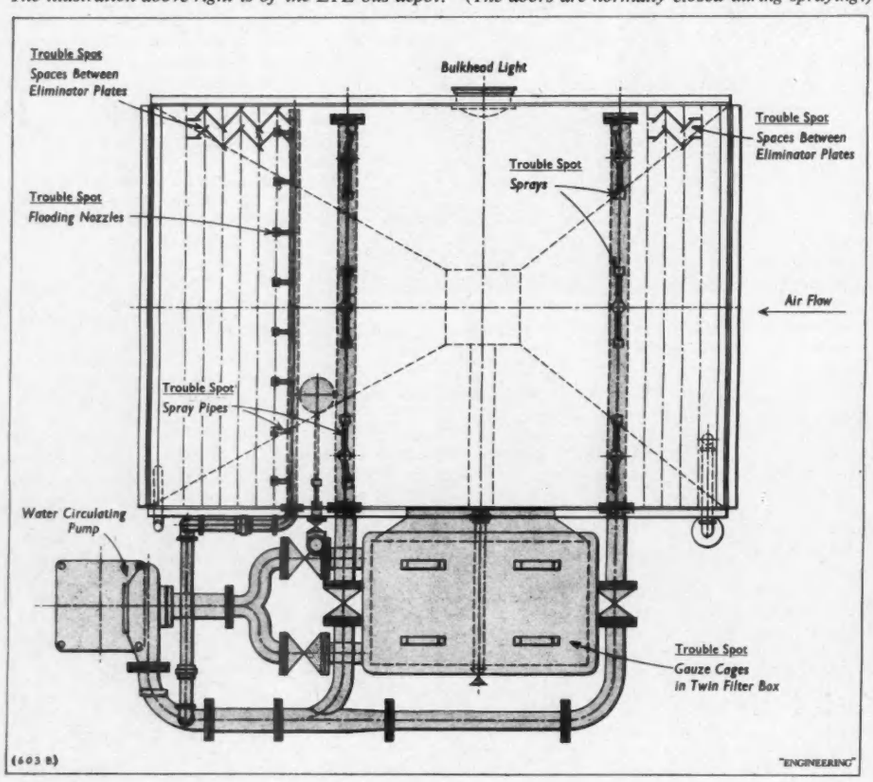
Panacide does not cause corrosion. On the other hand, it is not a corrosion inhibitor, so that it will not stop aggressive action due to causes other than microbiological.

In these days when protection against occupational hazards is of primary importance, the non-toxicity of Panacide—another claim of BDH—is of great advantage. It is not a skin irritant, being, in fact, used medically in skin preparations, and in a pharmaceutical grade it is even taken by mouth for the treatment of parasitic infections.

Acknowledgement is made to Mr. R. J. Collins, technical development manager of BDH, for his cooperation in producing the article.

British Drug Houses Limited, Laboratory Chemicals Division, West Quay Road, Poole, Dorset.

Shown below is a diagrammatic plan of air circulating equipment for a bakery; note the trouble spots. The illustration above right is of the LTE bus depot. (The doors are normally closed during spraying.)



"Bad Eggs" in Paint Spray Booth

The huge modern depot at Aldenham where the London Transport Executive repair and maintain the London buses was troubled by the smell of bad eggs in some of their paint spray booths; this trouble could, at times, be so bad that the smell became intolerable. Concerned about the health hazard, the management sought advice and the trouble was cured by the use of small amounts of Panacide added to the water tanks of the affected booths.

The paint shop at this depot has all the air from the spray booths drawn through a curtain of recirculating water. Any paint overspray is picked up by the water spray and broken down by chemicals added to the water which cause it to separate out when reaching the tank; it may then be removed. Whilst the chemical additives are not too costly, it was a matter of simple workshop economics to make each charge of treated water last as long as possible. Before the addition of Panacide the tanks were having to be cleaned out weekly, and sometimes more often than that. These booths are now cleaned once a month as routine.

In this case the bacteria were thriving in the water/sludge mixture, reducing the sulphates present to hydrogen sulphide—hence the smell of rotten eggs. The makers comment that Panacide is quite effective in the presence of chemical additives.

Air Washer Troubles in Bakery

In the modern large bakery provision must be made for cooling the bread after baking. To achieve the high degree of control necessary at the cooling stage the loaves are circulated in a tunnel supplied with cool air of controlled humidity. The air for the cooling tunnels comes through a spray-washing system which can be the source of much trouble, since the recirculated water is extremely prone to bacterial slime growths. The growth of the bacteria is

facilitated by the gradual accumulation in the water of small quantities of flour, fats and mineral salts removed from the processed air.

Most modern bakeries will be found to suffer from this nuisance and a typical example was the bakery of Frears and Black at Leicester. The installation was designed and engineered by two of the most important food machinery engineers in the country and the appearance of slime was in no way attributable to the engineers or the design of the plant, comment BDH. Wherever one has decided to use water in such a recirculating system the growth of slime bacteria is virtually inevitable.

Before embarking upon the Panacide treatment this bakery, in common with many others, was having to clean out the water trough in the humidifier once a day. Since the introduction of 100 parts per million of Panacide, it has only been necessary to clean out once a month as routine maintenance. The manufacturers of the plant are reported to have been so impressed with the results that they now supply the first three months' doses of Panacide with each new installation and further advise their clients to continue with the treatment thereafter.

Slime Blocked Air Conditioning Plant

In the National Gallery the use of Panacide enabled the engineers to remove growths of slime which were giving trouble in the air conditioning plant. The plant, which was designed and installed under the supervision of the Ministry of Works, had been running trouble-free for ten years continuously, but after extending the air conditioning service to further galleries, trouble suddenly struck.

In a picture gallery of this sort elaborate precautions have to be taken if the pictures are to be maintained in perfect condition. All air enters the building through one of five conditioning plants and is distributed by a system of ducts; access to these ducts is difficult.

The humidifiers are of the water curtain type operated at a temperature chosen so as to keep the humidity of the air in the room under precise control. In practice, there is usually a slight extraction of atmospheric moisture into the 2,000 gallon water system.

When the slime began blocking the jets, Panacide was added to the water and within three days large amounts of dead slime began breaking away from various parts of the plant. After removal of the dislodged slime a small maintenance dose of the same chemical ensured that there was no recurrence of the trouble, say BDH.

Confectionery Cooler Suffered Growths

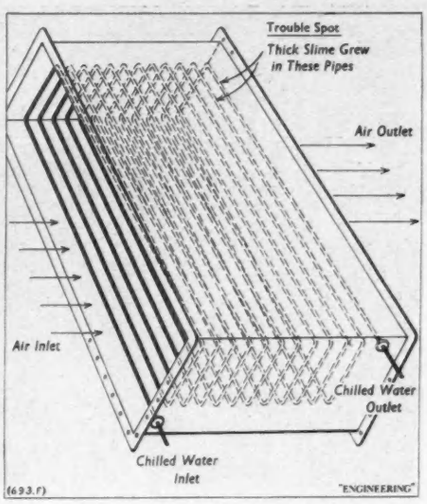
Mass production of confectionery at the Mars factory at Slough demands strict control of temperature and humidity. An extensive water cooling system is employed for this purpose consisting of two wooden cooling towers with pumps and a system of enclosed piping through which approximately 200,000 gallons of water per hour are pumped to condensers and heat exchangers. This water is recirculated to satisfy process and refrigeration requirements necessary to give high product quality under adverse conditions. Prior to using Panacide, large quantities of algae and slime developed in the towers and piping incurring considerable manual effort to clear the growth. Since the use of Panacide was introduced, it is reported that no further trouble of this nature has been experienced.

Wooden Cooling Tower Clean and Intact

The Aircraft Research Association at Bedford take great pains to ensure that the cooling circuit on their wind tunnel is in perfect condition. This consists of a water circulation system with a wooden cascade cooling tower feeding an outdoor concrete-lined pont. Light and dust combine to make this an ideal site for algal growth which could seriously impair the efficiency of the heat exchangers.

BDH have advised on the chemical control of algal growths in this system for several years. Two years ago the presence of strains of algae resistant to the standard chemical treatment was detected. These resistant algae were brought under control by the addition of 20 parts per million of Panacide to the cooling water.

If the chief engineer had had to depend solely upon chlorination, the high concentrations required could, in this case, have led to serious deterioration of the timbers of the cooling tower. This tower is, however, as good as new after five years' use.



Some idea of the confectionery installation can be gained from this.

This is the cooling pond and tower; note that the wood grain is still visible on interior timbers.

Humidifier chamber in the National Gallery—slime blocked the water jets.

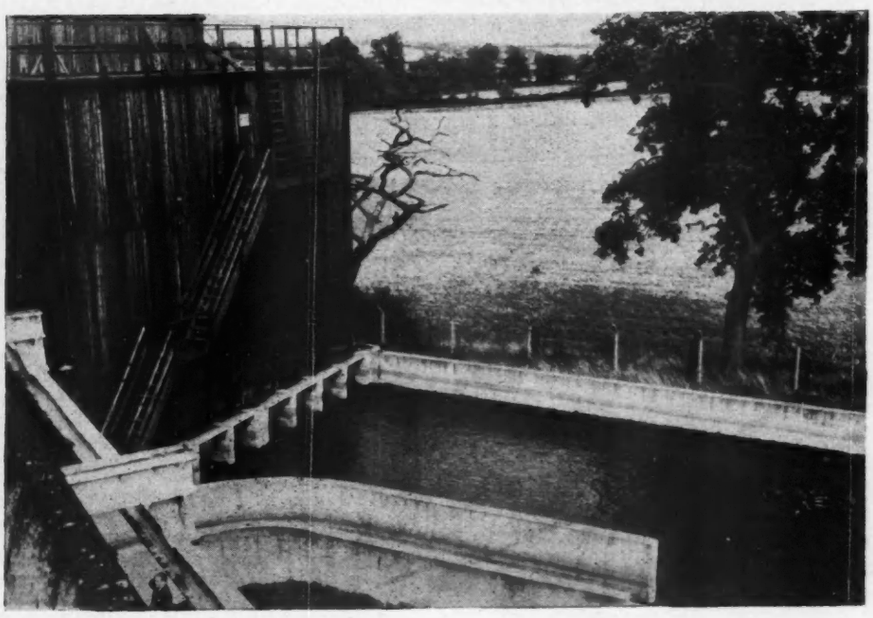


Fig. 1 The source of neutron pulses for the Harwell Neutron Project consists of a multiplying target which is bombarded by electrons at 25 MeV.

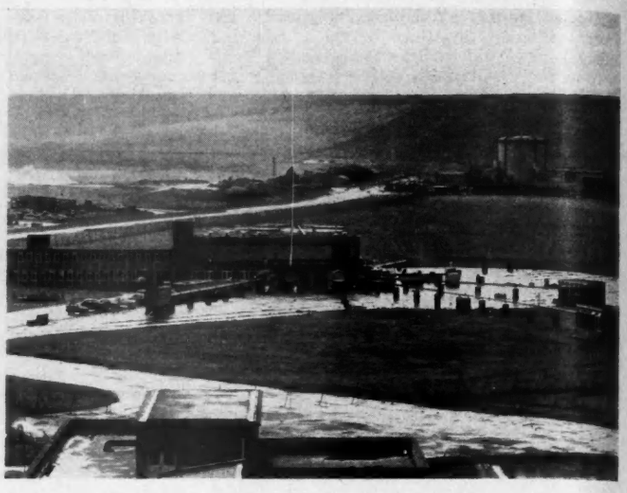


Fig. 2 After leaving the assembly under study, neutrons travel along flight tubes (placed radially around the Neutron Project building) and are electronically sorted.

Determining Neutron Energy Distribution

A knowledge of the neutron spectrum from a given reactor system can be a vital factor in reactor engineering. Several research techniques are now being used for such measurements.

By R. S. Hall, M.Sc., Ph.D.

It was observed in 1934 by workers investigating the properties of the newly discovered neutron that the amount of activation induced in a foil by neutrons from a radioactive source was greatly enhanced when there was a quantity of water, paraffin wax or other hydrogenous material in the vicinity. It was suggested by Fermi that the additional process taking place when the hydrogenous material was present was the reduction of the energy of the neutrons. This had two rather surprising corollaries: (1) that the interaction rate increased with decreasing neutron energy—this was in direct contrast to previously studied interactions using charged particles, where the probability of a given reaction taking place was increased by raising the energy of the bombarding particle; and (2) that if the neutron loses energy by collisions with the light nuclei, it is only reasonable to suppose that it does so until it reaches thermal equilibrium with the molecules of the medium—that is, the neutron takes up a Maxwellian energy distribution, whose energy at the most probable velocity corresponds to the temperature of the medium (see Fig. 3).

On further consideration the first point appeared to be not unreasonable, as the charged particles have to overcome the Coulomb barrier surrounding the nucleus in order to produce an interaction, whereas the neutron, being uncharged, can easily penetrate to the nucleus, and physically and crudely, the longer it spends in the vicinity of the nucleus, the more likely it is to interact.

If these two propositions were correct, then it was considered that it should be possible to test them both by looking for a change in activation of a foil due to a change in the energy distribution of the neutrons, the latter being brought about by changing the temperature of the medium with which they were in thermal equilibrium. This was first done by Moon and Tilman in 1935, and gave a clear indication that a change in the temperature of the medium produced a change in the neutron energy distribution, and that the interaction rate (i.e. activation) was dependent on the neutron energy.

This early work gives us, therefore, the knowledge that in order to make any predictions about the reaction occurring in a material exposed to neutrons we need to know the energy distribution of the neutrons, and the way in which the chance of a reaction changes with neutron energy.

In order to determine these factors we need some means of obtaining the energy distribution of neutrons from any given source, and then to be able to select a range of energies and find the change of probability of interaction (of which the "cross-section" is a measure) with neutron energy for the medium under investigation. No further detailed consideration will be given here to the measurement of cross-sections. It has been mentioned to indicate the reason for interest in the neutron energy distribution and attention will now be given to some of the different methods that are available for measuring the energy distribution from various sources.

Mechanical Shutter

The kinetic energy of a neutron, E, is given by the simple relation $E = \frac{1}{2}mv^2$, where m is the mass of the neutron, and v its velocity, for the range of energies under consideration. Thus if a burst of neutrons is released at the same instant of time, as they spread out in all directions, the more energetic neutrons will get ahead of the slower, less energetic ones. If we can allow the neutrons to travel a sufficient distance for the different energies to be well separated in space, it is possible to devise a mechanical shutter which can be operated at such a time that only neutrons of a particular velocity, and hence energy, get through.

The apparatus which is used for this resembles that used to measure the velocity distribution of molecular beams. In the diagram (Fig. 4) S is the steady source of neutrons in the thermal region, C and C′ are collimators, D is the detector, and A and B are discs of a material which is opaque to neutrons, but in each of which is a slit which will permit neutrons to pass. Disc A performs the function of producing the neutrons in bursts, the distance d between A and B allowing the neutrons of different velocities to separate by virtue of their different times of flight, and disc B acting as the mechanical shutter which defines the particular neutron energy to be selected. The slits in discs A and B are displaced angularly with respect to one another on the rotating shaft—by δ radians, say. Then the time taken for a neutron of velocity v' to travel from A to B is $t' = \frac{d}{v'}$, and during this time the discs must have turned through an angle δ, if this particular neutron velocity is to be the one detected. If the frequency of revolution is f per minute, then $t' = \frac{d}{v'} = \frac{\delta}{2\pi} \times \frac{60}{f}$

$\therefore f = \frac{v'}{d} \times \frac{\delta}{2\pi} \times 60$. As an example, if the angular separation of the slits is 10°, $d = 100$ cm and we wish to select a neutron velocity $v' =$

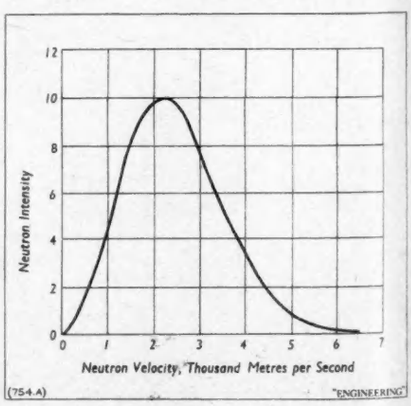


Fig. 3 Maxwell distribution of thermal neutrons at 20° C.

Research Report

by a member of the

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Physics Department
University of Birmingham
Edgbaston, Birmingham 15

2,200 metres per second (which is the most probable velocity of a thermal neutron at 20° C), then $f = 3{,}660$ rpm.

Thus by suitable choice of values one may select the neutron velocity by choice of the speed of rotation of the shutter. One limitation on this is the resolution—this arises because the slits must have a finite width in order to pass any neutrons at all, and if they are finite, a small range of neutron velocities is passed at any given shutter speed, so that there is a blurring of the information obtained about the energy distribution. A mechanical difficulty arises from this: in order to keep the resolution to a minimum, it is desirable to spin the discs at as high a speed as possible—speeds of up to 15,000 rpm have been used for some work.

Rotating "Chopper"

An alternative to this, but using exactly the same principle of velocity selection by time of flight, is to use one rotating "chopper" near the steady source, to produce bursts of neutrons, as before. At the end of the flight path, which may be very much greater than that mentioned above (up to 300 metres), a neutron detector is used which can be made sensitive for very short periods of time, with a variable delay between the chopper "open" time, and the detector sensitive time. In this way it is possible to construct a plot showing the variation of neutron intensity at the detector with time, after the burst of source neutrons from the chopper (the first neutrons to arrive being the fastest, etc.) which is directly related to the velocity distribution, as discussed earlier.

The form of the chopper will be somewhat different to that schematically illustrated in Fig. 4. It is usually a rotating cylinder formed from a multiple sandwich of a neutron absorbing material and some non-absorbing material: e.g. cadmium and aluminium respectively. One version of this is shown in Fig. 5. This permits two bursts of neutrons to pass for each revolution of the chopper. As can be imagined, to use such a device revolving at high speeds requires considerable refinement of mechanical design, if it is not to disintegrate.

For neutrons with energies above those of thermal equilibrium the chopper design is somewhat different. The beam of neutrons impinges on the end of a cylinder which has a slit running along its length, so that a burst of neutrons is released each time the slit moves through the beam. Normally there will be several slits along the cylinder, but the diagram (Fig. 6) shows only one, for simplicity. The cylinder is of the order of a foot long, to give a good "on" to "off" ratio. In all these experiments, if the neutron flight path is of any appreciable length, it takes place within an evacuated tube, to reduce the loss of neutrons from the beam by scattering in the air. As described so far, the detector sensitive time would have to be varied manually, to produce a complete picture of the neutron intensity at different times after the pulse. However, a refinement of this latter technique is to use a multichannel time analyser on the detector output. This sorts the detector pulses into a continuous series of channels of equal time width, starting after the chopper burst is released, thus continuously producing a full picture of what is happening.

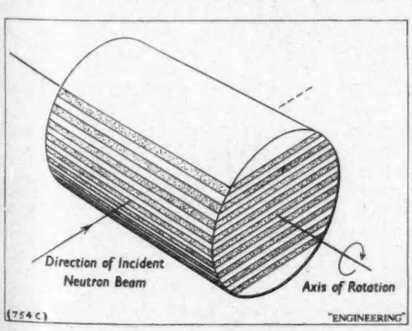


Fig. 5 A chopper for slow neutrons, using alternate layers of cadmium and aluminium sheet.

It should be noted here that the fully mechanical system is a velocity *selector*, and could be used to produce a beam (intermittent) of nearly monochromatic neutrons, or merely as a spectrum analyser, whereas the electronic system is purely an analyser, as it does not produce a monochromatic beam. A compensation is that the analyser covers the whole range at once, whereas the selector measures only one energy at a time.

Pulsed Neutron Source

Another somewhat more specialized device eliminates the mechanical chopper, whose function is to divide into bursts the neutrons coming from some system under study. In this case the neutron source itself may be pulsed, so that the neutrons come already in bursts from the medium—this cannot be done when the spectrum to be studied is coming from a critical reactor, of course. The neutron source will be the target of some type of accelerator—the accelerator beam is pulsed, so that the neutron yield must also be. After leaving the assembly under study the neutrons travel over flight-paths and are electronically time-sorted as before.

Crystal Diffraction

A completely different technique, that of diffraction from a crystal, is widely used as a velocity selector. This uses the property of a

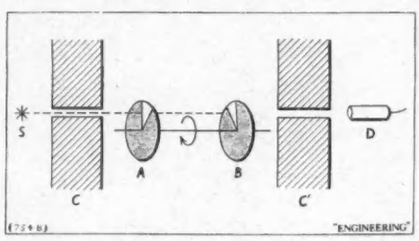


Fig. 4 Principle of the mechanical velocity selector.

neutron which enables it to be treated as a form of wave, its wave length being dependent on the neutron velocity. The process which takes place is directly analogous to that in which light waves are diffracted from a grating—very closely spaced lines ruled on a plane surface. In this neutron case the diffraction is from the evenly spaced rows of atoms in the crystal lattice—very similar to X-ray diffraction, but with the difference that X-rays interact with the electrons round the atoms, whereas the neutrons interact directly with the nuclei. Neutron diffraction can therefore give information concerning the arrangement of the nuclei within the atoms of a lattice, whereas X-rays yield knowledge of the atomic situation only.

A narrow beam of neutrons is allowed to fall on a crystal, and by choosing a suitable angle, a given neutron wavelength can be selected, and hence a beam of neutrons of a certain energy obtained. The energy spread is dependent on the degree of collimation of the neutron beams—high resolution implies high attenuation of the neutron intensity. This device is similar to the all-mechanical velocity selector in that it can provide a monochromatic neutron beam for use with cross-section measurements, as well as providing a means of analysing the neutron spectrum present in the incident beam.

Neutron-Absorbing Foil

The devices so far described which are suitable for measuring reactor spectra are used with a beam of neutrons extracted from the reactor and emerging through a hole in the shielding. In some cases this is neither possible nor desirable, and yet some means is required which will enable an assessment to be made of the reactor spectrum. For example, in a reactor designed for producing power (and using natural, or low-enrichment uranium) it is of economic importance that the fuel remain in use as long as possible. However, as fuel is irradiated, a fissionable plutonium isotope is produced, which after a time may be in sufficient quantity to change the reactivity of the fuel. This type of effect must be predicted when the core is newly charged, and as the rate of formation of the plutonium isotope is rather sensitive to the effective neutron temperature within the core, it is essential to have a knowledge of the neutron energy distribution present.

An estimate can be obtained of the effective neutron temperature by using as a detector a foil of a material which is strongly neutron-absorbing over a narrow energy band, provided that the equivalent velocity band is just on the edge of the Maxwellian distribution. Thus a slight shift of the position of the Maxwellian will cause an appreciable change in the number of neutrons absorbed by the detector. Such a material is lutecium, and the technique of using it for the determination of effective neutron temperatures in various systems is now well established.

Threshold Detectors

It is possible to obtain some estimate of the distribution of the higher energy neutron using threshold detectors. These use as the sensitive element a material whose activation cross-section does not become appreciable until some lower limit of neutron energy has been exceeded. Thus by using a set of these whose thresholds cover the neutron energy range of interest, an integral measurement is made of the higher energy neutron distribution.

The importance of knowledge of the neutron spectrum can perhaps be finally illustrated by reference to a reactor type in which success or failure depend on the neutron spectrum: this is a fast reactor used as a fuel breeder. A fast reactor uses highly enriched fuel and fissions are produced by neutrons with energies considerably above those of thermal motion—fissions caused by neutrons at these energies tend to provide more neutrons than those from fissions produced by thermal neutrons, and the extra neutrons can be used to generate more fissionable fuel in a blanket of a suitable material (e.g. U^{238}) surrounding the core. Thus the number of neutrons to spare for breeding is dependent on the neutron energy being kept as high as possible in the core, and in the experiments which take place before the design for a full-scale reactor is completed, great attention is paid to determining the neutron energy distribution present, using every available technique. The determination of neutron spectra is a field in which there is much work taking place at present, and which offers the prospect of a better understanding of the processes in operation when neutrons are slowed down by, and interact with, a medium.

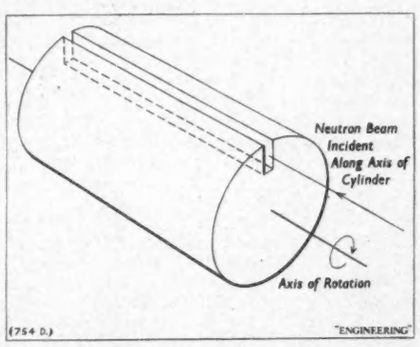


Fig. 6 Chopper used for neutrons with energies above thermal; constructed from high-strength material.

XUM

On the Shelf

By Frank H. Smith

FROM now on, if I catch anybody running down the Post Office I shall leap for my challenging gauntlet, mount my charger and, lance in hand, rush to that body's defence. I had to get a picture of an old mail coach in a hurry. I rang their archivist (one of those fascinating HEAdquarters numbers), explained my difficulty and by first post next morning had two versions of mail coaches together with a colour negative.

More glossy stuff from an oil firm. Number 1 of *BP Magazine* has the sort of cover that won't even take ballpoint writing and tons of the old coloured material in the pages. Very plush, but mostly oil. If you want a copy, drop a card to the Editor, BP Magazine, The British Petroleum Company Limited, Britannic House, Finsbury Circus, London EC2. And remember—there's no fuel like an oil fuel.

Although it is entirely Albright and Wilson, their " Survey of a Chemical Group " is one of the most luxurious firm's-virtue-trumpets that I have seen. On the glossiest of thick papers, its place on a school library table (or in a university reading room) should fetch in the recruits like ground-bait in a river full of fish. A chronology ranges from Artie Albright's birth in 1811 to the latest absorption of W. J. Bush and Company Limited in 1961. Were they vintners they would need no bush. Want a copy? 1 Knightsbridge Green, London SW1.

The American Society for Engineering Education, University of Illinois, Urbana, Illinois, announces *Engineering College Research Review* for 1961 at $4. It is a biennial (now which *is* that—hah! wallflowers, second year after planting) and summarizes 11,000 projects in 121 institutions representing $180 million. Address your order to Prof. W. L. Collins, Secretary at the address I gave.

The Times Bookshop, Scientific and Technical Dept., 42 Wigmore Street, London W1, do a couple of useful " new book " lists. One is electrical engineering and the other mechanical. If you send for them you'll probably get a great sheaf of publishers leaflets as well. I'm not sure whether Times have just started this Sc. and Tech. Dept. in a big way or whether they have only just got their sights on me.

The Japan Society of Mechanical Engineers ladles out a very fat *Bulletin*. No. 14 of Volume 4 (pp. 193 to 430!) contains a six-part paper, " Studies on the Characteristics of Axial-Flow Pumps," by Tomitaro Toyokura.

Knowing my partiality for history (who says?) the British Iron and Steel Industry Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London SW1, have kindly sent me Trans. BISI 2026 Springorum's " The Development of Metallurgical Processes and Production Methods 1860-1960 with 113 refs " (from *Stahl u. Eisen*); BISI 2027 Ochel's " Examples from the Historical Development of Steel Shaping " (*S.u.E.*); BISI 2028 Kallen's " The Function of Steel in Technical Developments in the Last Hundred Years " (*S.u.E.*); BISI 2035 Rheinlander's " The Development of Technology and its Influence on the Cost Pattern of Iron and Steel Production " (*S.u.E.*); and BISI 2134 Daves's " Investigation of Antique Iron Components from Cologne Cathedral " (*S.u.E.*). Quite frankly, the price gave me the shudders, but if you are interested I am sure it will not deter you from inquiring.

American plumbers are a crowd of Ph.D's, judging by National Bureau of Standards Monograph 31. It is *Capacities of Stacks in Sanitary Drainage Systems for Buildings*. Maybe it's for architects, and in case anybody wants it HMSO will get it for the equivalent of 35 cents. As far as I can see, the gist of its 52 pages is " if you're using the wrong size pipe your system's gonna get bunged up."

Thoughts for the Heirs

The Inheritors. By RITCHIE CALDER. *Heinemann.* (25*s*)

In 336 pages, Professor Calder claims to have written the Story of Man and the World he made. Nor does the story stop in the year 1961, for by a process of extrapolation it is continued to include a Summit Conference—an imaginary one—held in Arctic regions in the year 2061. To compare this exercise in condensation with an earlier one, H. G. Wells' *Outline of History*, is quite permissible inasmuch as Professor Calder is a self-confessed disciple and admirer of Wells. Certainly in the intervening 40 years Man has done quite a lot to alter his World, and historians have been busy in recording these efforts. We think not only of Toynbee and Taylor and Trevor Roper, but of Holmyard and Singer's monumental *History of Technology*.

The inheritance handed down to readers of *The Inheritors* is thus even more noble and magnificent than what was enjoyed by the readers of *An Outline of History*. As for the Inheritors themselves, Professor Calder tells us who some of them are. On the page next to the title page, we read (with apologies to Malthus) the names of the author and his wife, of their five children and of their seven grandchildren. When, therefore, the author gives us his views on family planning and population limitation, we can be sure that he will not interpret them in any negative or illiberal fashion.

As for the successive parts of the text, they are entitled " The Writing in the Sands," " The Tool-making Animal," " The Watershed," " The Streams of Civil zation," " The Bridge," " Hobnails of Chivalry " . . . These titles, and the remaining ones, are not intended for the literal-minded reader. Turning hopefully to the pages about " The Bridge," he must learn not to be disappointed if he finds nothing about the Forth Bridge or the Pont Valentré. Yet it is a strange kind of symbolism that uses " The Bridge " as a descriptive term for the entire American continent.

Even more obscure is the heading " Hobnails of Chivalry." Surely it will offer to so well-known a progressive as Professor Calder just the opportunity he wants to denouce the authoritative knights in armour or the equally tyrannical princes of the Church. But no. We read no complaints about the feudal system and its later developments. There is no criticism of " the cathedral cities with their permanent beauties of craftsmanship, the dedicated expression in stone, wood and glass of the arts of free men." Well, if the author says they were free . . . But could he explain the connection between Hobnails of Chivalry and the evolution of the steam-engine? Here in this part of the book we find an illustration of the little reaction turbine attributed to Hero of Alexandria, and another drawing of James Watt's double-acting rotative steam engine. These remind us again of the author's individualistic approach to technology, for he implies that Watt was the inventor of the steam engine. Elsewhere in the book are other odd implications that would confuse sober hydrologists and might seriously mislead general readers: such are the comments under the heading " The Subterranean Nile." Many of the illustrations, both in half-tone and in line, are excellent, as indeed they ought to be, for a number are reprodced by permission from *The History of Technology*.

In the end, one is left wondering how such a book as *The Inheritors* could be put to most effective use. Here is a suggestion. Might it not serve as a basis for discussion in the Liberal Studies course in a Technical College? Would it not widen the students' outlook if they were to follow up the clues that Professor Calder so copiously provides, and to compare their collective assessment of historical trends with the author's? All of us might profit from his reminder of the splendour of our inheritance, in language and traditions and political institutions as well as in technology.

HERBERT ADDISON

Microwave Double

Microwave Antennas. By A. Z. FRADIN. *Pergamon Press.* (£5 5*s*)

Microwave Ferrites. By P. J. B. CLARRICOATS. *Chapman and Hall.* (50*s*)

Microwaves form a portion of the spectrum with wavelengths roughly between 1 mm and 1 m, so lying between the more familiar infra-red and radio bands. Within this range, devices can conveniently be made of dimensions of the order of a wavelength and this fact, to a great extent, determines the theoretical and experimental techniques. The propagation of microwaves through hollow conducting tubes (i.e. waveguides) was first analysed by Lord Rayleigh in 1897, but it was not until 1936 that a group of workers in America presented any extensive experimental work. The Second World War, with its requirements for high-power radar, stimulated such rapid progress in the microwave field that by 1945 it could be said that the fundamentals had been well and truly established. Because the earliest experiments were at the longer wavelengths (just below the television bands) the approach was commonly that of the radio engineer, but as the subject has developed, so it has leaned more heavily on advanced mathematics and fundamental concepts of physics. These two microwave books cannot, therefore, be recommended as light reading for the radio enthusiast. They can, however, be fully recommended to the microwave engineers and research workers for whom they were written.

Out of courtesy to the foreign author, we will first consider *Microwave Antennas*. This translation from the Russian is of " a new substantially expanded and revised edition of the author's book which appeared in 1950." It is an excellent volume, being encyclopaedic in its coverage and systematic in its development. The fly-leaf is quite accurate in describing this as an authoritative volume—but unfortunately not in claiming that *all* questions are dealt with.

The book is eminently readable, with a careful presentation and systematic approach that inspires the reader with confidence. The mathematics employed is at a level no higher than that necessary for any detailed understanding of microwave antennas, yet the author has his feet on the ground sufficiently often to enable practical designs to be found with ease.

The first two chapters give a classification of antenna types and a clear exposition of the approach to solving antenna problems. An important chapter follows on diffraction from an opening in a plane screen. On this firm foundation the remainder of the book considers each class of antenna in detail—the waveguide, horn, lens, reflector, slot, dielectic, surface-wave and helical antennas.

Criticisms of the book are few. Non-letterpress setting and photolithography has been employed throughout, making reading less of a pleasure than it should be. The publishers apologize for this on the grounds of price and time. The saving in price may be worthwhile but hardly the saving of a few months in preparing for publication—especially as the most recent reference in the bibliography is dated February 1956. The bibliography will be useful mainly to familiarize the reader with Russian works—the references to Western literature are few. The very brief index is partly compensated for by a

detailed list of contents. The reproduction of the photographs is so poor as hardly to warrant their inclusion.

With the few reservations on the quality of production, this can be commended as an important new text and reference book.

Stepping back through (or is it under) the Iron Curtain, we find Clarricoats' *Microwave Ferrites*. Ferrite, familiar as the material used in rod aerials of domestic receivers, is a black ceramic-like material with unusual magnetic properties at microwave frequencies. Ferrite has a tensor permeability that enables many novel devices to be made and it is for the engineer interested in these devices that this book has been written. The author, himself an engineer, has worked on microwave ferrites almost since their introduction in the early 1950's, and so can command a fair view of the problems involved. The book is written in a clear and easy style, with emphasis on the practical application, and uses mathematics that should never be above the heads of intended readers.

Although the aim is towards the utility of ferrites, the author very properly opens with a few chapters on their basic physical properties. This important preliminary puts forward, for the reader unfamiliar with these things, a most readable résumé of our contemporary understanding of magnetism in ferrites. The meat of the book is in two chapters, the first of which concerns "Propagation through Ferrites and Ferrite-loaded Waveguides." Detailed consideration is given to a wide selection of waveguide structures, each with an eye to the final chapter on "Microwave Components Employing Ferrites," where the various devices are dealt with from the point of design and performance. The index and references are adequate and a representative bibliography is given in the earlier, tutorial chapters.

This book succeeds in what the author has set out to do, to provide the necessary theory and principles underlying these microwave ferrite components, and can be fully recommended to those who want to use and/or to understand these components.

J. B. DAVIES

Visual Approach to Engineering

The Adventure of Engineering. By DAVID JACKSON. *Rathbone Books.* (21*s*)

The vogue for large pictorial books ha reasserted itself after a decade or more out of fashion. It is fitting that engineering, in this case civil engineering, should play its part in the fashion, for engineering has not in the past used visual techniques in a systematic way to arouse the interest of the adolescent in the subject. Arousing the interest of the young is going to be, however, one of the engineer's main problems for the future as they encounter continuing competition for recruits from other technical disciplines.

Like all the publications from this source which have treated technical subjects, the approach is intelligent, stimulating and painstaking. Like the others there is a strongly evolutionary flavour in the treatment and an occasional Continental tinge. It packs in a great deal of information within a small compass from the evolution of civil engineering in primitive times to the patron saint of tunnellers—this last perhaps a belated and unconscious tribute to the Irish navvy of yesteryear, southern Irish, of course.

The projects chosen to illustrate the use and development of civil engineering have been well put together. The more formal types of illustration are particularly well done and the size of the pages is a big help. The colour, done like the rest of the book in photogravure, is patchy and the drawings may not appeal to some of the engineering profession but they give contrast and spaciousness to the treatment.

As an effort to stir the young imagination and to hint at the breadth and scope of civil engineering the book rates highly. From the engineering profession's point of view it has two main merits. First, it shows the possibilities which exist for the use of visual, explanatory techniques. Second, it shows how vividly these can be used for raising the interest of the young, younger than adolescent, in engineering.

The array of credit titles is impressive but someone should have spotted the mistake of equating "engineering" with "civil engineering" in the title.

G. E. TEWSON

Mixed Bag of Mathematics

Calculus and Analytic Geometry. By GEORGE B. THOMAS, JR. 3rd Edition. *Addison-Wesley Publishing Company, Reading, Massachusetts, and London.* (53*s*)

Calculus. By R. L. JEFFERY. 3rd Edition. *Toronto University Press, Toronto; Oxford University Press, London.* (40*s*)

Engineering Mathematics. By ROBERT E. GASKELL. *Staples Press.* (55*s*)

Mathematical Handbook for Scientists and Engineers. By GRANINO A. KORN and THERESA M. KORN. *McGraw-Hill, New York and London.* (£7 15*s*)

Modern Mathematics for the Engineer. Edited by EDWIN F. BECKENBACH. 2nd Series. *McGraw-Hill, New York and London.* (74*s*)

The International Dictionary of Applied Mathematics. Edited by W. F. FREIBERGER. *Van Nostrand, Princeton, New Jersey, and London.* (187*s* 6*d*)

Linear Algebra. By G. HADLEY. *Addison-Wesley Publishing Company, Reading, Massachusetts, and London.* (51*s*)

Field Computations in Engineering and Physics. By A. THOM and C. J. APELT. *Van Nostrand.* (30*s*)

Tables of Elementary Functions. By MIECZYSLAW WARMUS. *Panstwowe Wydawnictwo Naukowe, Warsaw; Pergamon Press, London.* (105*s*)

Mathematical Puzzles and Diversions from "Scientific American." By MARTIN GARDNER. *G. Bell and Sons.* (17*s* 6*d*)

Before the war it seems to have been relatively easy to decide what mathematics ought to be taught to engineers during their University course. Calculus, analytical geometry, an introduction to vectors and Fourier series, with a bit on Bessel functions, matrices, or probability theory to fill out—this was the general pattern of undergraduate textbooks. In most cases the treatment was down-to-earth and severely practical. Engineers, the argument seemed to run, had no need of mathematical rigour—they had a quality called physical intuition which would always keep their analytical work out of danger. Thus techniques were often described without their limits of validity being precisely defined, while such matters as uniqueness, if they were discussed at all, were usually "proved" by an appeal to physical argument.

Three post-war books on "Engineering Mathematics" head the list under review, and it is interesting to see how they reflect the advances in applied mathematics which have taken place during the last twenty years. At first sight there seems to be little change. There is no sudden drive to teach undergraduates tensor calculus, topology, or linear programming. And yet the change is there—in some ways a more fundamental change than the mere introduction of extra material. For all three authors realize that some of their readers will eventually need to solve complicated mathematical problems or learn advanced mathematical techniques, and that for them intuition is not enough. Accordingly they spend considerably more time on the fundamentals of mathematical analysis than was customary in pre-war texts. Ideas of continuity and convergence are presented carefully, in much the same way as they might be taught to undergraduates specializing in mathematics, and the reader is introduced to the jargon which mathematicians use when they want either to be precise or to impress their engineering colleagues. In fact in these books we find that the distinction between "Engineers' mathematics" and "Mathematicians' mathematics" has almost disappeared.

The first two books are the more traditional, and may be compared (to their advantage, it must be said) with texts such as Lamb's *Infinitesimal Calculus*. The most stimulating of the trio is the third, and it is significant, perhaps, that its author comes not from a university but from an engineering research laboratory. The coverage of topics is greater, and the examples have a real-life air about them which is most convincing. In many places, particularly in the treatment of differential equations, the mathematics is developed in relation to specific engineering problems in a manner reminiscent of Karman and Biot's classic. The treatment of numerical methods is good, with accounts of techniques, such as Newton's method for several variables, not usually found in textbooks of this kind.

There seems to be a fashion for all-embracing handbooks on this and that. It is debatable whether this trend is desirable, but the *Mathematical Handbook for Scientists and Engineers* is certainly a monument to the wide knowledge and industry of its authors. Here one can find accounts of topics ranging from vector field theory and Fourier transforms to statistics and abstract algebra. As might be expected, the information density is very high and the writing mathematically adult. Each section contains a clear and concise summary of all the important results and methods in a particular field, in a form which is convenient to a person who already knows the field well. But the inexpert trying to learn something about a new branch of mathematics will find the going almost impossibly tough. The material is very well set out, the cross-referencing is excellent, and there are excellent tables of conformal transformations, Fourier and Laplace transforms, integrals, etc.

Like the first, the second volume of *Modern Mathematics for the Engineer*, is a collection of disconnected papers describing various recently-developed mathematical techniques. The material ranges from the theory of linear operators to queueing and inventory techniques, with a visit to Monte Carlo on the way. The going is uniformly hard and a complete understanding of the material demands considerable mathematical ability. The layman, however, may get from this book an exciting glimpse of what present-day mathematicians are doing and the sort of problems they are trying to solve.

Doubts about the wisdom of trying to cram a mathematical library into a single book are intensified when one looks at the *International Dictionary of Applied Mathematics*. If you want to know what a "bigit" is, this book will tell you. It will also tell you that the "Multiplication of Tensors" is "The operation of

forming the product of (two) tensors." After such enigmatic brevity it is surprising to find that "Reciprocity theorem, mechanical rectilineal" and "Reciprocity theorem, mechanical rotational," have two separate entries which together take up nearly a page.

It is unfair, however, to criticize a book of this sort by picking out unsatisfactory entries—most of them are everything that a dictionary entry should be. There are also good multi-lingual indices in German, Russian, French and Spanish. But your reviewer found it difficult to imagine a situation in which he would find the dictionary continuously useful. Factual information, such as physical constants, is already well-catalogued elsewhere, while one thing which would have been useful—reference to more extended accounts of the subject of each entry—is not included.

Dr. Hadley's book on linear algebra gives a good mathematical treatment of a subject which is of growing importance to engineers and economists. Modern developments such as linear programming are included, but there is disappointingly little on computational techniques. The worst things in the book are the sub-titles chosen for the chapters. The use of quotations for sub-titles is not necessarily bad—for example, they add considerable pleasure and point to Jeffreys and Jeffreys' *Methods of Mathematical Physics*. But the inclusion of Rom. XII,2 as the sub-title of the chapter on linear transformations adds neither wit nor point to the material, and some of the others are just as bad.

Professor Thom's book is really concerned with the finite difference solution of partial differential equations. Much of it is concerned with methods appropriate to desk calculating machines, but anyone interested in solving field problems on computers will also find it valuable. In particular, the authors' advocacy of the use of high accuracy finite difference patterns with a relatively coarse mesh will find many supporters in the computer field.

Any new set of tables of elementary functions inevitably has to stand comparison with Chambers' 6-figure tables, prepared by the late Dr Comrie. The tables prepared by Dr. Warmus cover much the same functions, with about the same ranges and intervals. In some cases, such as reciprocals, the range of the new tables is greater, and the inclusion of inverse tables for all functions has some advantages. However, the type-fount used for the new tables is not as easy to read as that used by Comrie, while in the matter of price the older tables also score. One feature of Dr. Warmus' tables which may be of value to some users is the statement of maximum possible error which appears on each page.

Finally comes the short book by Martin Gardner. This is in the Rouse Ball tradition and is sheer delight. Not only are there absorbing problems in logic, probability, and topology. There are also fascinating discussions of mathematical and geometrical paradoxes, methods of memorizing numbers, polyominoes, and games such as Nim. It comes as a welcome reminder that, whether useful or not, a piece of good mathematics is always a delight to the receptive mind.

R. K. LIVESLEY

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Component Items

Stop Valves. BRITISH ERMETO CORPORATION LTD., Beacon Works, Hargrave Road, Maidenhead, Berkshire. Leaflets relating to the range of high-pressure stop valves Type 509. Specification and dimensioned diagrams are given. The range covers nominal bores from ¼ to 1½ in with integral Ermeto end connections, and ⅜ to 1¼ in BSP. Four double-sided sheets, ill.

Friction Materials. FERODO LTD., Chapel-en-le-Frith, Stockport. A catalogue containing details of linings, clutch discs and inserts, cone clutch linings, pads, friction wheels, sintered metal and cermet facings, and drive belts. Sections are devoted to the excavator band replacement service and the Ferolok method of simplified lining attachment. 270 pp., ill.

Valves. J. BLAKEBOROUGH AND SONS LTD., Brighouse, Yorkshire. This publication, No. 252, relates to valves for nuclear applications. Those for reactor gas ducts include valves of the gate and butterfly types up to 78 in in size. Among valves supplied for use on subsidiary CO_2 circuits are screwdown and parallel-slide ones. Other items for use on these circuits are check valves, diaphragm-control valves, and reactor charge-discharge valves. 11 pp., ill.

Valves and Cathode Ray Tubes. FERRANTI LTD., Gem Mill, Chadderton, Oldham, Lancashire. Data sheets relating to receiver valves, television tubes, industrial valves, cathode ray tubes (industrial), and microwave equipment. 28 sheets, ill.

Electrical Equipment

Unit Contactors. ALLEN WEST AND CO. LTD., Brighton, Sussex. Folder covers new range of unit contactors, Type UAC, having extra capacity and suitable for multi-contactor assemblies. Main features: double-break silver faced main contacts, compliance with BS 775, four electrical interlocks, "clip-on" body. 4 pp. ill.

Torque and Speed Control Units. PYE ELECTRIC LTD., Lowestoft, Suffolk. Publication 0516 giving general description and specification of a range of units. The TASC master (PI-speed) model BCB gives 20 to 1 speed control for units 1J2 (½ hp) and 1J4 (¼ hp), these having applications on conveyors, winding drives, test rigs and mixers. Double-sided leaflet, ill.

Car Bulbs. WESTINGHOUSE LAMP DIVISION, WESTINGHOUSE ELECTRIC CORP., Bloomfield, New Jersey, USA. List of equivalent Westinghouse bulbs for head, tail and side lights of most European cars. Folder, 6 pp. ill.

DC Power Supply Units. CLAUDE LYONS LTD., Valley Works, Ware Road, Hoddesdon, Hertfordshire. Leaflet gives brief account and specifications of the new Type PSS-32/50 high-current stabilized power supplies. Single-sided, ill.

Signalling. WESTINGHOUSE BRAKE AND SIGNAL CO. LTD., 82 York Way, London N1. Leaflet on Westatic Rectifier Feed Set describing operation. 4 pp., ill. Leaflets on relays Style PL2, PN1, PN1A, PN21, PSP1, and PSR1. 2 pp., ill.

New Books

Oil in the Middle East. By STEPHEN HEMSLEY LONGRIGG. 2nd Edition. *Oxford University Press.* (35*s*)

Brigadier Longrigg traces the development of the oil industry in the Middle East (from Egypt to Persia and including Cyprus and Turkey) from the earliest times up to 1960. For this edition, five chapters have been added on the chief producing countries, and the maps are new.

Science Information Personnel. By LEONARD COHAN and KENNETH CRAVEN. *Science Information, PO Box 624, Radio City Station, New York 19.* ($1·50)

Outcome of an investigation (sponsored by the Modern Languages Association of America) of the function, status, recruiting, education and training requirements of information scientists.

Engineering Management and Administration. By VAL CRONSTEDT. *McGraw-Hill, New York and London.* (66*s*)

For general managers of the smaller manufacturing firms who want to know how their engineering departments should be operated; for engineering managers and administrators who are responsible for the execution of such an operation; and for the technical people who wish to discover by what principles they are being—or should be—managed.

Management Control Systems: Proceedings of a symposium held at System Development Corporation, California, July 1959. Edited by DONALD G. MALCOLM and ALAN J. ROWE. *Wiley, New York and London.* (58*s*)

Emphasis is on the application of computers to simulate company activities, thereby creating a management laboratory where the effects of policy and procedures can be tested and evaluated prior to their adoption.

Progress in Operations Research. Volume 1. Edited by RUSSELL L. ACKOFF. *Wiley, New York and London.* (92*s*)

Collection of 11 expert contributions tracing the progress in eight areas of operational research: inventory theory, linear programming, dynamic programming, queuing theory, sequencing theory, replacement theory, simulation and gaming. In addition, there is a chapter on decision and value theory. The treatment is critical as well as expository.

The International Dictionary of Physics and Electronics. 2nd Edition. *Van Nostrand, Princeton, New Jersey and London.* (£10 5*s*)

Upwards of 12,000 entries are prefaced by a review of major developments in physics since Newton. A four-language glossary (French, German, Russian and Spanish) is appended.

Field Theory for Engineers. By PARRY MOON and DOMINA EBERLE SPENCER. *Van Nostrand, Princeton, New Jersey and London.* (96*s*)

Assuming their readers to have a good background knowledge of differential equations, vector analysis and elementary physics, the authors demonstrate the application of boundary-value techniques to a variety of electromagnetic, acoustic, thermal and gravitational problems. Descriptions are included of Eisenhart's eleven coordinate systems, bicylindrical, bispherical and toroidal coordinates.

Handbook of Fluid Dynamics. Edited by VICTOR L. STREETER. *McGraw-Hill, New York and London.* (£9 6*s*)

Prepared by a panel of 31 experts, this is directed to the engineer or scientist with some background in fluid mechanics and the appropriate branches of mathematics. The first half of the work is concerned with fundamental concepts and principles, the second with applications. Stratified flow and magneto-hydrodynamics are included.

Case Studies in Electromagnetism. By HERMANN A. HAUS and JOHN P. PENHUNE. *Wiley, New York and London.* (52*s*)

The purpose of this volume is to provide the undergraduate with measured guidance in solving electromagnetic field problems himself, both analytically and experimentally. The first part presents a variety of analytical problems, followed by detail solutions; the second part is a laboratory programme.

Circuit Analysis. By ELLIAS M. SABBAGH. *Ronald Press Company, 15 East 26th Street, New York 10.* ($8·75)

Aiming at electrical engineering undergraduates, Professor Sabbagh has written an introductory text to circuit analysis based on the field concept, gradually leading up to such topics as network topography, three-phase systems and magnetically-coupled circuits.

Iterative Arrays of Logical Circuits. By FREDERICK C. HENNIE III. *Massachusetts Institute of Technology, and Wiley, New York and London.* (40*s*)

This monograph—doctoral thesis at the Massachusetts Institute of Technology—presents a logical examination of the properties of the various classes of iterative networks and of the tests that are available for answering certain simple questions about them.

The Reviewers

Mr. Herbert Addison, O.B.E., M.Sc., M.I.C.E., M.I.Mech.E., is a consultant and author with special interest in hydraulic engineering, irrigation, and land reclamation. From 1921 to 1951 he was lecturer and professor in hydraulics and hydraulic machines in the faculty of engineering of Cairo University.

Dr. J. B. Davies, M.A., M.Sc., is a research mathematician in the Systems Division of the Mullard Research Laboratories, where he is engaged in work on microwave physics, with special reference to ferrites.

Mr. G. E. Tewson, M.A., is a partner in the firm of O. W. Roskill, industrial consultants.

Dr. R. K. Livesley, M.A., Ph.D., is a Fellow of Churchill College, Cambridge, and a University Lecturer in Engineering. His main work has been on the application of computers to engineering problems.

Marketing

Increased Production of Russian Oil

The USSR has long been regarded as a power given to performing what would outwardly appear illogical things. However these are seldom done without good reason and it is a subject for speculation why, at a time when there is potential world surplus of oil, Russia should be endeavouring to increase her output by 100 per cent within seven years, this target being part of the latest plan of that duration launched in 1959. She has already displaced Venezuela as the world's second largest oil producer and by 1965 intends to be producing 230 million tons, roughly equivalent to the 1959 production of the entire Middle East.

It is true that Russia's internal consumption is increasing but not as sharply as production. Also, a number of tankers and pipelines are being constructed suggesting a substantial increase in the amount of Russian oil available for export.

Only recently has there been any oil surplus and Western Europe, which in 1957 imported no Russian oil, took 75 per cent of the 22 million tons marketed outside the Soviet Bloc in 1959. Last year, it derived from that source about 8 per cent of its somewhat greater requirements.

What effect will this have on the free world? The position has now changed from a decade or so ago when with oil in short supply, any new supplier readily found a market. It is now definitely a buyer's market. Two of the largest consumers at present are Japan and Italy who take appreciable quantities as part of reciprocal trading agreements. Such transactions are of course carried out at Government level but in addition to this there are a number of independent concerns, with no fixed source of supply, anxious to obtain oil at the lowest price. To these the Russian proposition frequently appears singularly attractive as, outside the Soviet Bloc, prices quoted are highly competitive. Inside the position is vastly different and Poland for instance pays twice as much as Italy.

From this it would appear that Russia may well be in a position to subsidize to a certain extent exports to any part of the world where she is particularly anxious to obtain a market. In this case, it will be futile for the western oil companies to fight a price war as Russian losses may be recouped from inside the Soviet Bloc. On the other hand Russia lacks the intricate distribution networks built up by the large international companies and essential to sales. To instigate these systems would be a task involving vast expenditure.

On the surface, a long-term trading agreement for Russian oil may appear an attractive proposition, especially as by this means a market may be found for commodities difficult to dispose of elsewhere in the world. However this does tend to reduce the flexibility of supply so essential in the case of an emergency. Also it is well known that Russia proposes, eventually, to become self-sufficient in all commodities; in which case it will be of vital importance that no country involved has become excessively dependent on her imports.

With these factors in mind it seems true to say that there will be an appreciable increase in future in exports of Russian oil to the Western world but it is vital that their proportion of total supplies should not be allowed to become excessive.

Joint Engineering and Building Centre

Birmingham's new engineering and building centre is to be opened in the heart of the city's civic centre next March. The centre will be in Broad Street which is also the commercial centre of the city and in the middle of the extensive rebuilding that is going on in Birmingham.

Formerly the city's Masonic Hall, the rooms are being re-styled, and the entrance and staircases re-modelled, in a £100,000 alteration scheme.

In a modern setting, which employs a new form of display unit arranged in a novel manner designed to encourage inspection, it is expected that many of the country's best known engineering companies will be exhibiting their products. The exhibition will be permanent in as much as it will always be open but ever-changing because manufacturers will be free to alter their displays as new products are brought out. Almost everything from door knobs to tool steels and turbines will be on show in the 37,000 sq. ft of exhibition space that will be available.

The new centre is a direct descendant from the city's Iron and Coal Exchange which was founded in 1861 and flourished for 80 years. Its place was then taken by the Birmingham Exchange and Engineering Centre in Stephenson Place, but the requirements for space have outgrown that available. Moreover, the lease in Stephenson Place has run out (after two extensions) and the new accommodation has been obtained. It will be brought into use as the Stephenson Place centre closes down.

Simultaneously with the move, the Engineering centre is joining with a building centre which will act on behalf of the building trades, so extending the scope of the exhibits. As at the London Building Centre, the lighting fittings, wall coverings and floors will all be natural in situ exhibits.

In addition to the display rooms, there will be reading, writing and refreshment rooms, secretarial services, locker rooms, lecture halls with projection equipment, a catalogue library and a full information service for inquirers. Representatives of exhibitors will be able to use the centre as local offices if their firm has no other accommodation in the Midlands.

Efforts are to be made to establish the educational value of the centre and in this it will be helped by being adjacent to the new municipal exhibition hall that is about to be built.

A Successful Leipzig Fair

In spite of the somewhat tense political situation which gave rise to the threat of possible boycotts, the Leipzig Autumn Trade Fair held from 3 to 10 September admirably fulfilled expectations.

Prior to the opening, Herr Rolf Lemser, Head of the Fair Office, told a Press conference that the trade target with western countries was DM 700 million. This figure was actually surpassed by 78 million and the grand total of concluded contracts finally came to DM 2,923 million. Of this export contracts constitute DM 1,815 million (DM 652 million with western countries) and import contracts amounted to DM 1,108 million, of which the western quota was DM 126 million.

The Fair was visited by some 200,000 people from 76 countries, 12,000 of them coming from the West. 23 British firms exhibited as against 20 in 1960 but the space they occupied (5,000 sq. ft) was 100 per cent up on last year. There was a general trend towards increased space and better exhibits common to almost all exhibitors with the notable exception of Western Germany, whilst the attendance from that country was rather sparse at first but increased considerably towards the end. In all 494 of the 672 firms who had booked space exhibited although the figure on the opening day was only 400.

Plans are well advanced for the much larger Spring Fair to be held in March, 1962. This year 225 British firms were represented and the booking schedule gives every indication of next year's contingent being well in excess of this.

Fast Patrol Craft for Malaya

VOSPER Limited of Portsmouth, the shipbuilders who specialize in high speed craft have received a £1 million order from the Malayan Government for the supply of six Fast Patrol Craft to the Royal Malayan Navy.

Of welded steel construction the craft will measure 103 ft long overall and be propelled by Bristol Siddeley Maybach diesel engines. Maximum speed will be in the region of 25 knots. As a navigational aid they will be fitted with DECCA true motion radar and armament will consist of two Bofors 40 mm guns.

To combat the heavy seas encountered by craft sailing in far-eastern waters the hull design will incorporate Vosper roll damping fins.

Increase in Trade with East Germany

There was an increase of over £2 million in Britain's import-export trade with East Germany during the first seven months of 1961 compared with the corresponding period in 1960, which in turn was £3 million more than the same period in 1959.

Board of trade figures put the value of goods imported from East Germany up to 31 July 1961 at £4,464,542 compared with £3,962,638 in 1960 and £2,853,426 in 1959.

Exports this year totalled £5,168,163 compared with £4,289,596 in 1960 and £1,667,569 in 1959. Total British-East German trade (including re-exports) for the first seven months of this year came to £11,192,648 which is more than double the 1959 figure.

As can be seen the rise in exports is much sharper than imports and continues the general trend towards a growing market for British goods behind the Iron Curtain, a healthy position which if it is maintained, will be both a help to the nation's economy and make a direct contribution towards the improvement of East-West relations.

Presenting the Past

The Museum of Science and Industry, at Newhall Street, Birmingham, in the comparatively short time during which it has been in being, has formed a most interesting and valuable collection. Expansion of the scientific and industrial equipment is assured by the far-sighted policy pursued by those responsible for the collection. Already items which might be regarded as being in their prime have been ear-marked for preservation. This contrasts splendidly with the procedure of some other museums in the past, when items were on occasion recovered, sometimes quite fortuitously, from the scrap heap.

The Birmingham collection has several claims to world distinction, for it is believed to be the only museum where plant may be seen working under steam, and it is particularly rich in machine tools. It also has large and very important collections of firearms, motor cars, and bicycles. An incidental claim to distinction is the clarity with which it is signposted—a feature appreciated by the many visitors who come from far beyond the City's boundaries.

A valued acquisition, recently handed over, is a Hancock oxygen profiling machine built in 1924. The builders organized a competition to find the oldest machine of their make still at work. The prize, a new model of the latest version of the old machine, was won by DAVIES Brothers and Company Limited, of Wolverhampton. Among those present at the handing over will be Mr. L. J. Hancock, founder and a director of HANCOCK and Company (Engineers) Limited, Mr. E. Seymour-Semper, managing director, and representatives of the museum and of the competition winners.

Expansion in Fastener Production

AVDEL LIMITED, who specialize in high-speed industrial fastening systems, among which are Chobert rivets and huckbolts, have moved into larger premises at Welwyn Garden City. The decision to rehouse the business was based on the increase in demands for these fastenings, particularly from aircraft manufacturers, railways, and firms producing commercial vehicles, domestic equipment, and agricultural machinery.

The new premises, which have office accommodation extending to 16,000 sq. ft and a production area of 76,000 sq. ft, are well planned both from the viewpoints of production and personnel; the concept both internally and externally is modern. Ample space has been allowed for future expansion.

The opening ceremony took place on 20 September and was performed by Mrs. Johnson, wife of Mr. Stanley T. Johnson, the founder and original managing director of the business, which, until the name was changed earlier this year, was known as Aviation Developments Limited. The products have world-wide distribution and it was in the light of the fact that a large proportion of its fasteners are now used outside the aircraft industry that the change in name was decided on.

XUM

Stothert and Pitt DD2 Dockside Crane

What factors cause a leading port authority to order no less than 92 new cranes of a similar type from one manufacturer?

FIRST of all, what makes a good dockside crane?

To find the answer ENGINEERING approached the Port of London Authority, perhaps the largest user of such cranes in the world with over 550 on their books. The characteristics of a good crane can best be summarized:

(1) It must comply with British Standard 2452 and the customer's own requirements.

(2) It must be able to run from an ac distribution network, and yet retain certain dc characteristics, notably increased hoisting or lowering speeds with lighter loads.

(3) It must set a high standard of operator comfort with a comfortable seat, simple controls and a good view of the load in any position.

(4) It must offer low maintenance costs in terms of good all-round access, the minimum steelwork area for painting and the least practicable lubrication requirements.

Though the time honoured crank, screw or rope luffing cargo crane with lattice jib and tower construction and the driver standing at drum-type controllers has given excellent service for many years, it is now becoming an anachronism.

Of all sections of the heavy engineering industry, that of cargo-handling dockside cranes is one of the most conservative. This factor, coupled with the large amount of capital investment which a new purchase represents, tends to discourage any radical design changes, however rational. When a change does take place, not only is it the more startling, but it also reflects the greater credit on the instigators. With dockside cranes it was Stothert and Pitt Limited of Bath who made the first break and startled the British crane industry in 1959 with the introduction of the DD2 type. At that time the pressing need for a change was recognized not only by the leading crane makers but also by some of their best customers.

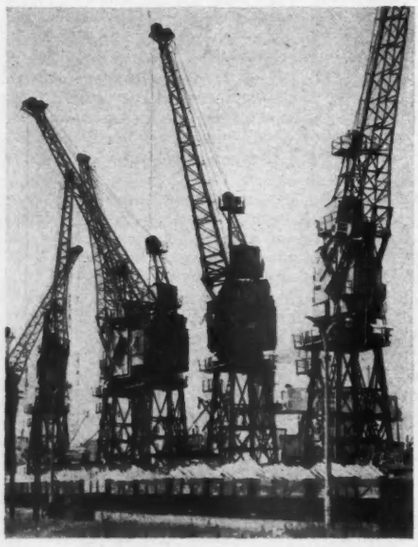


Fig. 1 Dockside cranes are gregarious by nature as these Stothert and Pitt crank luffers show.

Fig. 2 The excellent view from the DD2's cab.

Most port authorities, and the PLA are no exception, order dockside cranes in batches of a dozen or more spread over a period, in order to take advantage of a price based upon steady flow production. This forward planning characteristic of the dockside crane industry is beneficial to both manufacturer and customer alike, and might well be seriously considered by other industries. Apart from the direct advantages, it gives rise to a friendly spirit of mutual co-operation which undoubtedly helps towards a general pooling of ideas on the design side.

Particulars of Typical DD2 Type Cranes.

	5 tons at 80 ft radius model	3 tons at 65 ft radius model
Jib centres	90 ft	72 ft
Tail and clearance radius	10 ft 6 in.	10 ft 6 in
Rail centres	13 ft 6 in	10 ft 1 in
Cab floor height	47 ft. 10in	39 ft 9 in
Jib foot axle height	59 ft 9 in	51 ft 8 in
Hoist motor hp	60	45
Hoist maximum speed	0 to 5 tons 425 to 150 ft/min	0 to 3 tons 425 to 180 ft/min
Slew speed	1½ rpm	1½ rpm
Luffing speed	0 to 160 ft/min	0 to 160 ft/min
Travel speed	50 ft/min	50 ft/min

The smooth lines and good looks of the DD2 seem to echo the atmosphere which surrounded the embryo stage of a tool that is just right for the job. The customer cannot go to the crane maker and design a new crane for him, particularly if he has been ordering cranes of an earlier successful design in quantity for 25 years or more; but he can make his desire for improvement known in other ways. He can drop hints, particularly when ordering a special purpose crane, by insisting on a different cabin layout or by having a welded tubular jib. It is then up to the crane maker to redesign his standard article incorporating such known new requirements, together with other improvements of his own, when he feels it is prudent to do so having regard to his market as a whole.

No British dockside crane maker could possibly entertain the idea of redesigning his standard 3 to 6 ton crane in the years immediately following the Second World War. Postwar port rehabilitation schemes brought a flood of orders which kept the whole industry busy for several years. Furthermore, Stothert and Pitt knew that several customers desired no departure from the highly respected crank luffing crane with its years of trouble-free service.

However, British dockside crane makers were not unmindful of the changes in design that were taking place on the Continent. Germany in particular, with her heavy industries flattened and a port like Hamburg to re-equip, took the opportunity of developing new designs of dockside crane making extensive use of welded plate construction. But such cranes were not generally acceptable outside the Continent, as the material used was of a light gauge, and they did not comply with anything approaching British Standards. They did not provide an immediate incentive to British crane makers to follow suit.

SPECIAL DESIGN TEAM

The decision taken by Stothert and Pitt in 1957 to engage a special team of graduate engineers, not specialists in crane design, to formulate an entirely new approach was logical if not inevitable. The post-war port rehabilitation orders had dried up. Continental manufacturers had strengthened their all-welded designs to the extent that they were starting to offer serious competition in some of the company's overseas markets. Additionally, there were signs that their biggest customer, the forward thinking PLA, were no longer satisfied with "the medicine as before"—effective though that medicine had undoubtedly been. The fruition of the design team's efforts, the DD2, emerged as perhaps the biggest single advance in dockside crane design since the inception of the portal crane at the end of the last century.

Stothert and Pitt Limited, with 2,000 employees, is easily the largest firm in Bath and one of the largest engineering concerns in the Bath-Bristol area. Though cranes are synonymous with their name, cranes are not, and never have been, their sole engineering activity. Despite much of their history having been lost in the blitz, it is known that they were founded in 1820 as a foundry which was soon making a variety of engineering equipment including steam engines, cranes, special purpose machinery, and piston pumps. Cranes started with fixed hand cranes, followed later by rail mounted locomotive cranes. As the business grew, so the works expanded steadily westwards along a narrow strip of land between the River Avon and the main road to Bristol.

The increasing size of steamships soon created a dockside demand for a taller crane with more outreach. Before the turn of the century the self-propelled portal crane appeared, with the machinery house and jib base mounted on a tower through the base of which carts and railway wagons could be propelled. Water hydraulic and electric drive both came in before the First World War, by which time the popu-

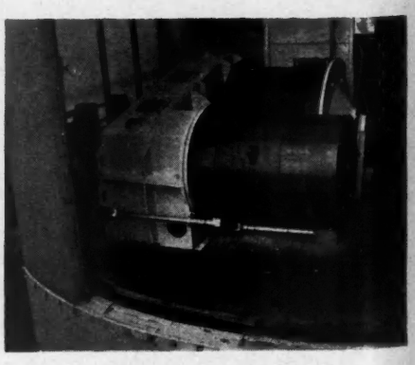


Fig. 3 The DD2's hoist gear and motor seen through the rear doorway.

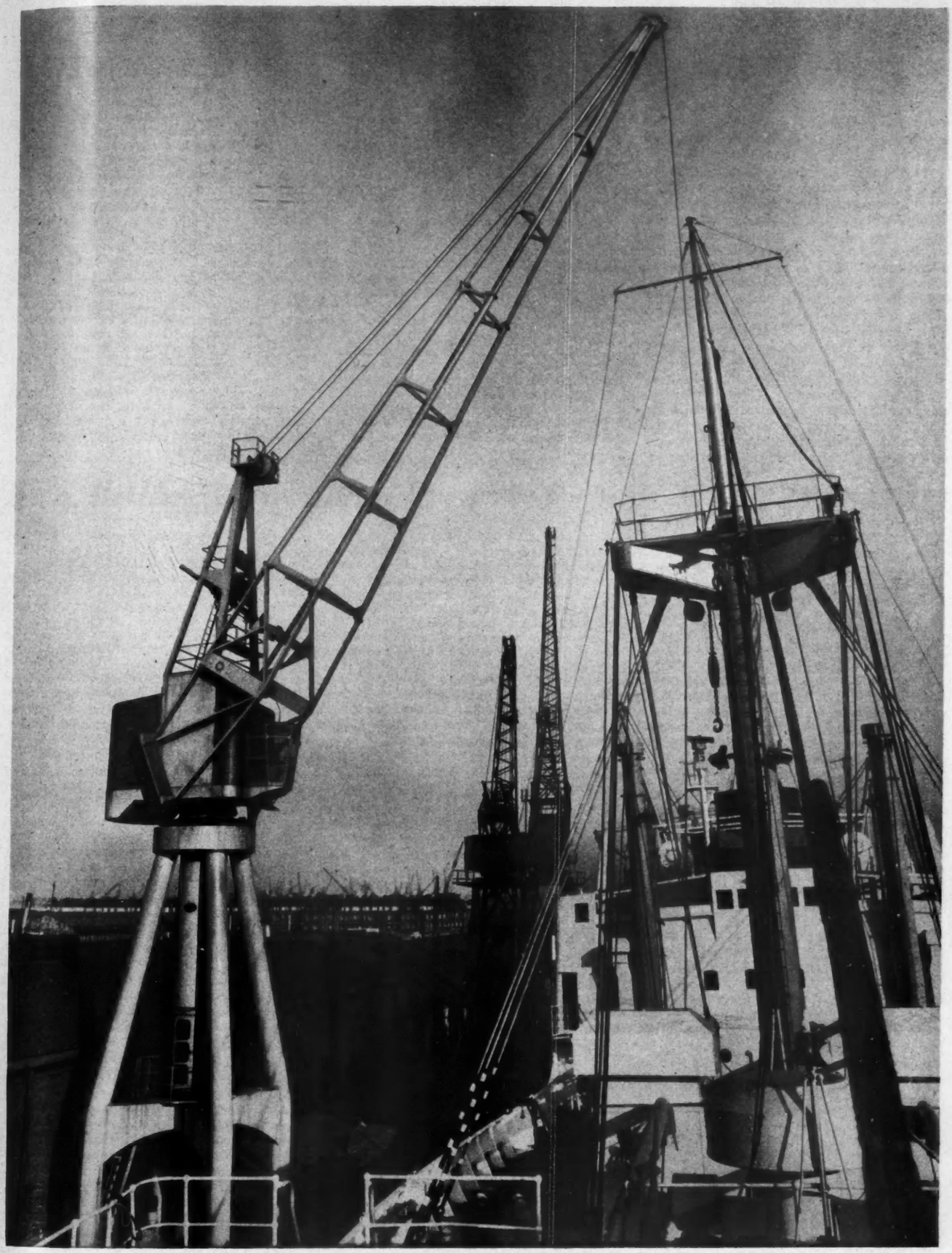


Fig. 4 Designed and styled by non-specialist engineers; a revolutionary approach to a long standing requirement.

larity of the 3 ton dockside crane lifting to a height of about 60 ft at 40-50 ft radius had become firmly established.

The introduction of DD2 was not the first occasion in Stothert and Pitt's history when they were responsible for an important crane development subsequently taken up by other manufacturers. A fundamental contribution was the level luffing system patented by the company's chief engineer named Toplis about 1914. It consisted simply of relating the length of the jib with the height of the apex, and reeving the hoist rope in such a way that when the jib is raised or lowered the load always remains at the same height. Level luffing greatly reduced the effort required for luffing and enabled the driver to predict the path of travel of his load.

Crank luffing was another major Stothert and Pitt dockside crane development, which came in during the 1920's. Luffing is performed by constant speed rotation of a pair of cranks, one either side of the machinery house, each coupled to a point on the jib by means of a connecting rod. This arrangement gives both rapid and positive control of the jib position, with the operational advantage of maximum luffing speed around the mid-position of the jib. In the DD2 a single hydraulic ram is used for luffing which offers an equally positive action and allows the jib head to be lowered right down to ground level.

"LARGE MEMBER" CONSTRUCTION

The most striking feature of the DD2 is undoubtedly the "large member" welded construction of the tower and jib. The lack of diagonal bracing is particularly noticeable, the jib struts having fixed end connections. Previous welded jib designs consisted in essence of conventional angle bar latticework with the joints welded instead of being riveted or bolted. The resulting structure was uneconomical in many ways, and in designing a welded jib from first principles for the DD2 the company utilized the excellent stiffness/weight ratio of hollow tubular members, plus the advantage of confining material to the points where it is structurally justified instead of being hidebound by standard rolled sections. The resulting design uses few site fitted bolts (making for easy erection) presents a smooth exterior with no pockets for corrosion and a reduction in area for painting, and cuts down wind resistance. The jib is fully balanced, the weights being triangular in plan to get the maximum moment with minimum weight and tail radius.

The construction of the tower is almost as revolutionary as that of the jib, and any reasonable track gauge can be accommodated. The PLA cranes are ordered for either 10 ft 1 in or 13 ft 6 in gauge. A long pintle tube attached to the underside of the superstructure is fitted at the upper end with three rollers which rotate inside a segmental path bolted to the top of the tower. The lower end of the pintle tube is supported by an oil immersed footstep bearing on the pintle platform. A spiral stairway inside the pintle tube gives totally enclosed access to the machinery house from pintle platform level, an important safety feature.

The electrical system, developed in conjunction with Mawdsley's Limited of Dursley, consists of a simplified Ward-Leonard set driving the hoist winch through totally enclosed gearing. The set has an exciter energized by the current in the armature loop circuit and which simultaneously controls the winch motor field and the generator field. This arrangement gives fully variable hoisting and lowering speeds controlled by the driver, and light loads can be hoisted at three times the speed of the maximum load.

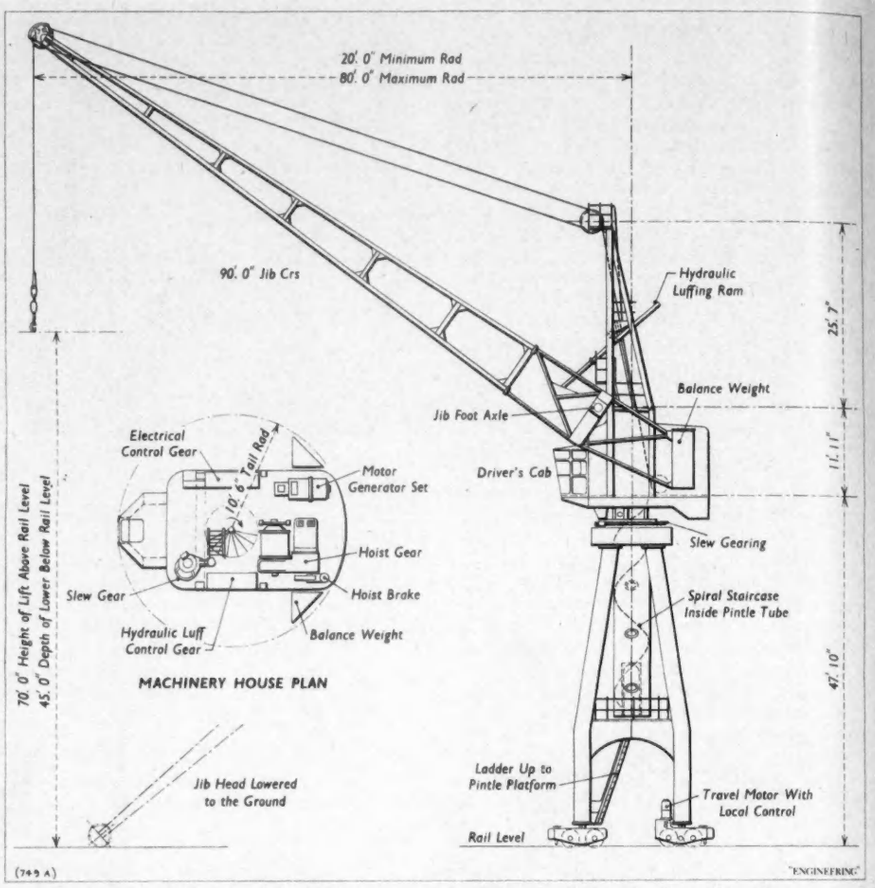


Fig. 5 Drawing of the DD2 5 ton model as being supplied to the Port of London.

Fully regenerative braking is employed, automatic on the lower notches, with an electromagnetic brake for holding the load in the "off" position and for an emergency. While the standard electrical system is designed for an ac supply, it is possible to use dc with little alteration to design.

The machinery house and driver's cabin are constructed mainly of resin-bonded glass fibre which is translucent and gives a light, airy feeling inside. All the machinery except the luffing ram and the travel mechanism is situated inside the machinery house in self-contained units. Ample space is provided for access and maintenance, and a wall crane inside the house is capable of transporting any of the machinery units through the rear opening doors to the ground.

The driver's comfort has been given every consideration. He has an adjustable seat and excellent lookout. Crane operation is by means of a pair of simple joystick controls. The use of sealed ball and roller bearings for all high and medium speed shafts reduces the need for greasing to not less frequently than once per year in most instances. All other bearings, except for lever gear within the house, are lined with graphite impregnated Ferobestos.

OTHER ACTIVITIES

Stothert and Pitt used to claim that they have cranes in every port in the world, and it is still close to the truth. But the company that has built up such a reputation on cranes has surprisingly diversified interests. They are divided into five divisions, concerned respectively with cranes, pumps, deck machinery, contractors plant (truck mixers, vibrating rollers and quarry plant), and multi-bucket excavators. The works have continued to spread along the bank of the Avon, and transfer of some of the larger crane items from one works to another necessitates a police escort. Expansion is a gradual process involving demolishing old residential property and rehousing at the firm's own expense.

There is a school of thought on the other side of the Atlantic that the dockside crane is outmoded and should be replaced by ships' own derricks. It is hard to see how such a system could approach the use of dockside cranes for speed of ship turnround, so vital in busy ports. The Institution of Mechanical Engineers are holding a discussion on this vexed subject on 6 November in London.

The aim in life of a dockside crane is to provide a port facility even if it means spending four-fifths or more of its life idle. It is by its speed of action during busy periods that it justifies its existence. The usual policy of a port operator today when ordering fresh craneage is to allocate one five or six ton crane to each berth, with five or so other cranes rated at 3 tons. The actual arrangement varies with the type of cargo the port habitually handles.

New dockside cranes are usually replacements for older cranes (and cranes have a life expectancy of 40 years or more) and have to suit the prevailing track gauge and clearance restrictions.

In the DD2, Stothert and Pitt have succeeded in producing a highly saleable and appealing product. With the 92 cranes being delivered to the PLA over the period 1961-63 and orders from other quarters on hand and in prospect, their crane division will be kept busy for some time to come. But with the reward of being first comes the penalty of bing imitated. Other crane makers are already trying to equal the achievement of DD2, which still leads in the dockside crane field.

Stothert and Pitt Limited, Bath, Somerset.

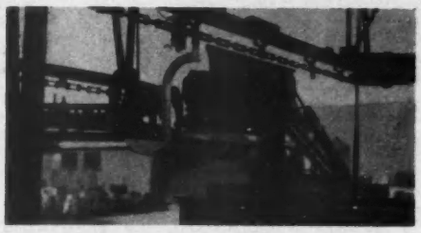
On the Move in a Russian Factory

When the 79 acre Russian tyre factory (ENGNG., 8 Sept., p. 314) at Dneipropetrovsk, in the Ukraine, begins shortly to turn out its projected 2 million variously sized tyres per year, the whole of its mechanical handling and conveying systems will have been supplied by Geo. W. King Limited. These systems have been built to meet the layout and equipment specifications recommended by Dunlop Advisory Services Limited, the consultants to Rustyfa Limited, the British consortium which is supplying the £14 million worth of engineering service plant and rubber and tyre manufacturing plant for the new factory. To meet production requirements, from the raw materials store fabric rolls are brought directly to the centre of the plant while raw rubber is delivered to the beginning of the production process. The fabric rolls, each weighing half a ton, are conveyed at a rate of twelve per hour to the fabric lines by a semi-automatic overhead runway in the form of a closed circuit incorporating five all electric "Marvex" hoists. The rubber, both natural and synthetic, is delivered to the manufacturing area in loads of about 480 lb each at a rate of something like 10 tons per hour. In the initial stages of production, further handling of rubber bales is by "Mytemin" electric chain block, fitted with a special grab, and by push-button controlled carriers.

After processing and rolling with protective liners, 25 cwt fabric rolls are conveyed from the two processing lines to any of eight storage racks by a complicated conveyor system involving cross-over lines and junctions. The racks, designed to hold eighteen 224 lb rolls, consist of two endless lengths of powered heavy duty bushed roller chain fitted with special attachments to receive the fabric roll box ends.

Another complicated part of the handling system is the point where ply rolls are delivered to band building and single ply tyre building machines by a "Dual Duty" light type overhead conveyor, the problem being that any combination of the sixty different types of rolls held in storage may be required at any of the tyre building machines. It has been necessary to design a complex of circulating, distributing and return conveyors feeding into and from the four conveyors, incorporating vertical "hugger" belts, which directly supply the four lines of tyre building machines.

After building, green tyres are removed by a powered overhead monorail conveyor equipped with saddle type carriers at regular pitch or, in the case of heavier tyres, by a semi-automatic runway system using six "Mytemin" hoists. Delivery of the green tyres to the curing presses, after inspection and painting, is by three separate overhead systems. Two powered conveyors take the truck and car tyres to 40 in and 55 in presses, while a "Dual Duty" conveyor takes the heavy duty tyres to the 75 in presses. Cured tyres are discharged automatically from the back of the presses on to belt conveyors and removed to the finishing department. After finishing, another overhead powered conveyor removes tyres to the finished goods store.



An example of the closely integrated handling systems. Automatic loading of rolls of rubber from a machine to a powered conveyor.

Geo. W. King Limited, Stevenage, Hertfordshire.

So a British Shipbuilder Can Make It

At a time when the British Shipbuilding industry seems, to use a nautical expression, to be in the doldrums (this week's Human Element discusses a British Productivity Council report which makes unfavourable comparisons with the Swedish industry) it is a pleasant change to hear that one shipbuilder appears to be going from good to better. Austin and Pickersgill Limited report from the North-East Coast that the 18,350 ton, 505 ft long ore-carrying motorship, Finnamore Meadow has been launched only nine working weeks after the erection of the first unit.

This first unit was erected on the 26 June and, with the shipyard holiday intervening, the actual launch was on the 6 September. If the company's production programme is met, as seems likely, delivery should take place in a further eight weeks, making a yard record of 17 weeks from the actual start of construction to completion of the order. The fortunate customer receiving this service is the Falaise Steamship Company, who will be registering the ship in Bermuda. Her Doxford type propelling machinery is being supplied by the North Eastern Marine Engineering Company.

Austin and Pickersgill have earlier shipbuilding feats of which they are also proud. They have completed eight ships in periods of from 21 to 28 working weeks, the vessels varying in type from an ore-carrier of 9,500 tons carrying capacity, a larger sugar carrier and some still larger dry cargo ships, to ore carriers, like the Finnamore Meadow, of around 18,500 tons carrying capacity.

The Finnamore Meadow is the third ship of her size to have been built by the company in recent months. The first reached the launching stage in 11½ weeks, and the second was launched in 10 weeks. It appears, therefore, that construction times are being constantly improved and the company predict still faster ones.

One of the major inhibiting factors in British shipbuilding since the last war has been the poor level of investment in new manufacturing plant and methods, particularly in the decade or so after the war. Austin and Pickersgill, however, do not have this inhibition for they have reconstructed their shipyard to an extent that can be gauged from the fact that ships of the Finnamore Meadow size used to be under construction for about 48 to 50 weeks a few years ago.

The company also seems to be free of the second curse of the industry, bad labour relations, a factor which is often a corollary of low capital investment, partly because inefficiency breeds discontent and partly because a management which is unprogressive in investing in plant is likely, also, to be unprogressive in its personnel policies (if any). Austin and Pickersgill have not experienced a major stoppage in three years.

Austin and Pickersgill Limited, Wear Dock Yard, Sunderland, Co. Durham.

High Output Galvanizing Line

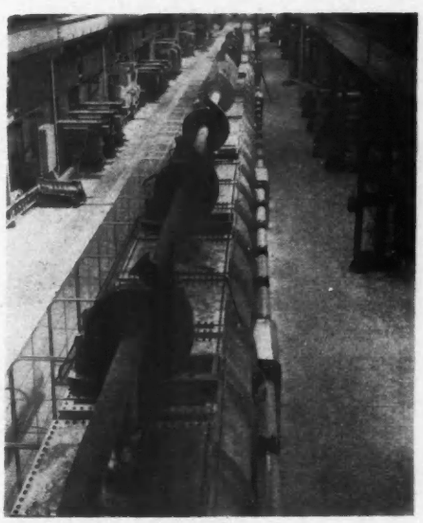
The demand for galvanized sheet and coil steel has not only increased considerably in recent years, but the pattern of industrial requirements for such materials has changed. In order to meet these new conditions, John Summers and Sons, the largest producers of galvanized sheet and coil in this country, have recently started up a new continuous hot-dip galvanizing line.

John Summers expect this line, the fourth to come into operation at their Shotton works, to increase output capacity of their special tight-coated sheet, Galvatite, by 50 per cent. The company, incidentally, claim to have installed the first continuous galvanizing line in this country in 1936, the only earlier one of its kind in the world having been installed in Poland.

Some idea of how the nature of the demand for galvanized sheet has changed can be gained from the fact that at first output was entirely for corrugated sheet, whereas today this is only 15 per cent of production, the balance being for flat sheet. The practice of earlier years was to manufacture many articles from black sheet, leaving the galvanizing stage until after fabrication, but present manufacturing techniques prefer to start with precoated sheet. Furthermore, the use of galvanized sheet is constantly being taken up in new fields: examples of note are in roll-formed sections, roof decking and acoustic ceilings.

All these trends have created a demand for a coating which will stand up to forming. Thought is also being given to the use of galvanized sheet for car underbodies—a technique which has been widespread in the US for some time. With each of their lines installed since 1936 John Summers have sought, by the control of heating and cooling, to achieve the tightness of coat and ductility required by these new developments. The second line started production in 1949 and the third in 1954. The fourth and latest line incorporates all the lessons of this evolutionary process, and uses a method of cooling the strip within the furnace which is entirely different from past practice. This new plant is capable of handling gauges from 28 down to 14, and coil and sheet up to 42 in wide, and it can run at a maximum speed of 150 ft per minute. The temperatures of all furnace zones are continuously recorded, and can be pre-set and maintained to within a 10° C variance.

John Summers and Sons Limited, Shotton.



The exhausts of the cooling zone, showing the clean and cylindrical lines of the plant.

Precision Flow for Car Transmissions

A new automatic transmission, just announced, opens up prospects of large scale demand in the medium-size car range. The manufacture and control problems involved in such high quality mass production are being met in a new £4 million factory extension.

THE Model 35 transmission now introduced by Borg-Warner Limited is likely to become for the medium-size car, in the 1½ to 2½ litre range, what their DG transmission has already become for the bigger car.

It has therefore been necessary to set up a manufacturing unit which can mass produce for this big potential market and yet maintain the high standard of precision demanded by the design features. This has entailed spending £4 million on new plant and a 140,000 sq. ft addition to the existing 175,000 sq. ft single-storey factory, and then re-integrating production of both the 35 and DG transmissions to attain high machine utilization and direct flow throughout manufacture.

As a wholly-owned subsidiary of the Borg-Warner Corporation of the USA, the British company has been able to call upon the valuable experience of the Warner Gear Division in setting up and maintaining its own production unit. Nevertheless, it has had complete autonomy over its own affairs and has introduced many of its own manufacturing and control ideas. The sophisticated and very necessary production control system, for example, is the brainchild of the management at the British factory.

The factory is geared up (to use an appropriate expression) to produce 400 Model 35 and 150 DG transmissions per eight hour shift, and plans are in hand for two-shift working. A number of British and European cars are expected to incorporate the 35 transmission shortly.

The proportion of the total factory area provided by the extension is shown in Fig. 1. It has not, however, been simply a question of moving the new equipment into the new extension. The whole production process for both the Model 35 and the DG—and also a third, less involved, product, an overdrive—has been analysed and the complete factory has been laid out as an integrated manufacturing unit. There is direct flow production for each product and virtually no back-tracking, even for heat treatment.

Faced with the gargantuan task of re-siting 500 machines, with minimum interruption to production, and installing 500 more, Borg-Warner's planning department decided to set up and experiment with a three-dimensional model layout of a type discussed in a recent article (ENGNG. 23 June, p. 868). By building, with the cooperation of Visual Planning Systems, the ⅜ in to 1 ft model shown in Fig. 2, they were able to compare different permutations of layout quickly and easily and, equally important, demonstrate the alternatives to management. During the planning stage, each likely arrangement was photographed to put it on record while alternative layouts were investigated.

Including handling and conveying equipment, two thousand model items were used in the three-dimensional layout and an example of the thoroughness with which this stage of planning was carried out is the way in which each model was marked with its plant number and then colour coded and given an operation number to ensure that it had its proper loading.

GOODS INWARD INSPECTION

A few quite minor adjustments have been made in the light of actual production experience on the shop floor but, by and large, the layout agreed at the planning stage in model form has functioned very successfully. Fig. 1 illustrates the relative positions of the different production areas and departments.

All incoming goods, whether raw materials or bought-out parts, are received at the goods receiving stage, the saw tooth outline at the top left hand corner of the layout. Each of the four off-loading stages or platforms is hydraulically adjustable for easy handling from lorries of varied heights and types, since one factor which Borg-Warner cannot control or standardize is, of course, suppliers' transport.

The quality of materials and parts is crucial in precision engineering of this type, and all incoming goods pass into a bonded area prior to examination by the receiving inspection department. This department carries out strict examination and testing and sometimes—for example, in the case of a new material or supplier—might arrange further testing in the metallurgical and development laboratories. Once accepted (there is a reject area for those that are not), materials and parts pass into a second bonded area from which the raw materials are distributed to the adjacent raw materials store and the bought-out components pass down the centre gangway, the whole length of the manufacturing area, to the bought-out parts store next to the assembly department.

In the raw materials store, most materials are

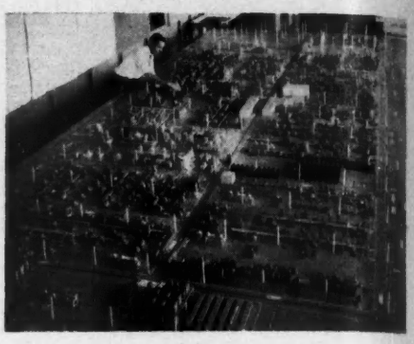


Fig. 2 Part of the model layout built with the cooperation of Visual Planning Systems.

stored in easily stacked and transported stillages and some, such as drive shafts, are stored in special wire basket type pallets in which they have arrived from the supplier and in which they are transported throughout the production process as far as assembly. Thus, palletization and quick and cheap batch handling are taken close to the ultimate. Within the stores area all materials are stacked as near as possible to the production area in which they will begin manufacture. From the raw material store they then flow in direct lines to final assembly.

A slight exception from the normal flow and arrangement of storage is made in the case of torque converter manufacture. The torque converter is virtually produced as a unit separate from the automatic transmission proper and does not join it until final assembly—indeed, the DG torque converter is actually sent to the motor manufacturer separately.

Bought-out parts for torque converters are therefore stored in the raw materials store in a position immediately adjacent to the torque converter department. Deference is also shown to the needs of this department in siting the press shop (which is concerned almost exclusively with presswork for torque converters) alongside the goods receiving stage with access to it. This means that the comparatively heavy raw material required by the press shop travels a minimum distance within the factory before being processed into smaller and more manageable parts, so reducing handling problems.

The press shop is equipped with completely new presses, the biggest of them being a 600 ton Wilkins and Mitchell downstroke press. When only the DG transmission was in production it

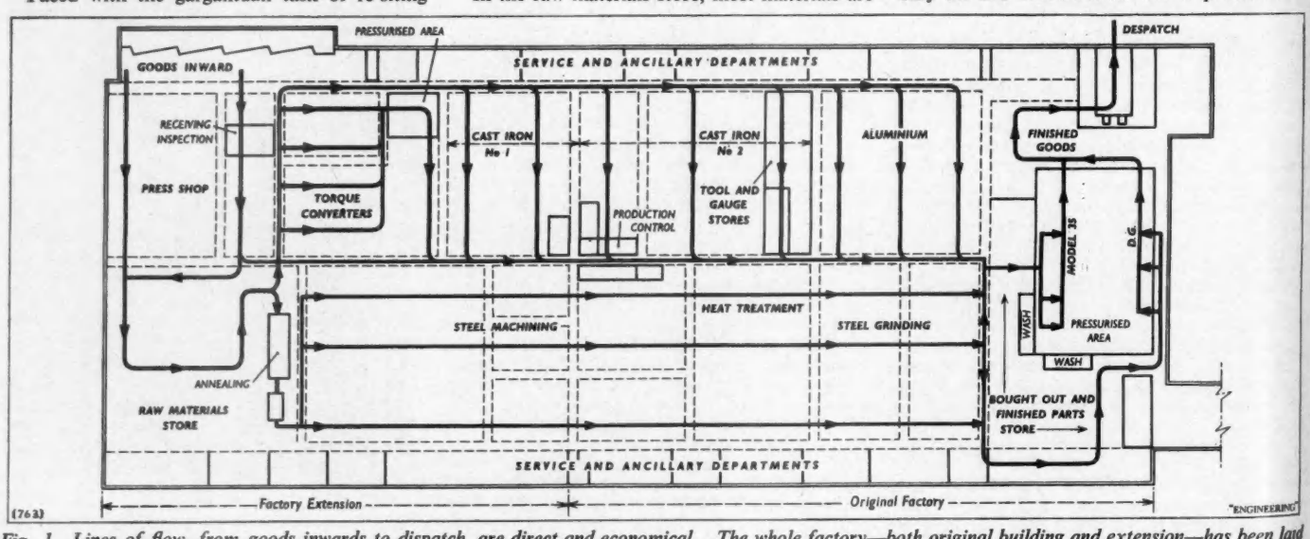


Fig. 1 Lines of flow, from goods inwards to dispatch, are direct and economical. The whole factory—both original building and extension—has been laid out as an integrated whole.

was not economic for the company to do their own presswork but, with the introduction of the Model 35, production will be of sufficient volume to justify the new press shop. This means that this important part of manufacture can now be fully integrated with the rest of production.

The machining work in the factory is carried out in the departments shown in Fig. 1 according to whether the material is steel, cast iron or aluminium. Broadly speaking, movement of material within a department is by gravity or powered roller conveyor or, at one or two points, by overhead conveyor fitted with cluster type jigs, while movement between departments is by pallet or stillage and Conveyancer fork truck. Departments are separated only by gangways, so that product flow is unimpeded and the overall layout is not made inflexible.

Both types of transmission have a high proportion of steel in their construction, mostly for the harder wearing parts such as shafts, gears, bushes, pinions, and inner and outer races. However, they do have very different proportions of cast iron and aluminium parts. In fact, one of the major features of the Model 35 (and one which has made possible the building of an automatic transmission of this sort light enough for the medium-size car) is its wide use of aluminium, particularly in the main case, extension case and torque converter housing. Conversely, in the DG transmission the main case and the extension, together with a number of other components, such as the assembly planet carrier, are of cast iron.

HEAT TREATMENT

Steel treatment and machining extends down the greater part of one side of the factory, from the raw material store through annealing, machining, heat treatment, lapping and grinding, to the machined parts store. The steels used chiefly are the SAE 8600 and 4000 series in the form of forgings and bar stock. Forgings go first to a continuous pusher type annealing furnace sited next to the raw material store. There was no such furnace in the original factory but this one has now been introduced to obtain the uniformity and close control of microstructure and hardness which is necessary to attain optimum machinability and freedom from distortion in the finished component.

Through the steel machining department, most parts are carried in wire baskets so that they can be routed through a number of plunge washes. Among the equipment in this department are two vertical broaching machines which are American in origin and can form all 67 helical internal teeth of the Model 35 ring gear in one pass—the first time, it is understood, that this operation has been accomplished in this country.

From machining, steel components flow directly into the heat treatment department. This department is sited in the position it had in the original factory and, because of the deep foundation work, was one of the few immovable objects with which Borg-Warner's planning engineers had to contend. However, they have succeeded in building it into the layout at precisely the correct point to maintain straight-through flow.

In this department, surface hardening of gears and other components is by carburizing, carbonitriding and, in the case of bearing surfaces, induction heating. Continuous, batch and pit type furnaces are used and distortion control is assisted by the use of Marquench techniques. After heat treatment, about 10 per cent of steel components are de-scaled and de-roughened by tumbling with stones, granite chippings or ceramics. Where less abrupt treatment is advisable, they are sometimes put through a vibrator with a polishing compound.

Heat treatment and its attendant de-scaling are followed, still in the direct flow, by lapping and grinding in the grinding department. As in the earlier machining operations, flow between stations is carefully coordinated, using conveyor feeds. The fully machined components are then transferred to the machined parts store.

Similar conveyor links and similar coordination between stations are employed in the cast iron departments. These two departments are smaller than the sum of those concerned with steel parts and they handle a bigger proportion of DG—and also overdrive—manufacture than work on the Model 35, but they do play an essential part in the latter. Among the plant introduced to handle Model 35 work is a Hoern and Dilts special purpose machine for machining the pockets in the front and rear cast iron pump bodies. Cast iron department No. 1 is concerned solely with the DG and overdrives, but an interesting feature of cast iron department No. 2 is that some machines handle both DG and Model 35 components and careful programming is necessary into and out of transfer lines.

The aluminium department is a particularly important and crucial part of Model 35 production. Not only the main case and the torque converter and extension housings but also the valve blocks, servo bodies and some ancillary components are made here. The department also produces valve blocks for the DG.

A major problem in making mass production of the 35 possible has been obtaining sufficiently high precision and low porosity aluminium die castings for the transmission main case. This difficulty has been overcome by an arrangement with Metal Castings Doehler Limited, who are setting up production in this country.

Perhaps the showpiece of the whole factory is the Burr Machines transfer line along which the main case is machined. This 130 ft long machine has a 10-station 40-spindle first section, a 21-station 95-spindle second section, and a 5-station 4-spindle finishing section. Mounted over a central floor flume that serves as a coolant return, it has a coolant system with a capacity of 8,000 gallons which are circulated at a rate of 500 gallons per minute with automatic chip separation and continuous filtration to maintain consistent cutting conditions. At the end of the line finished cases are pressure tested for oil leaks.

Another interesting operation in this department is the reaming process for finish machining of the valve bores in the die cast valve blocks. This process has been developed by the Warner Gear Division to get the accuracy and consistent finish necessary to give free movement of the valves. It employs carbide tipped reamers mounted in special chucks and used on Heald fine boring machines. These reamers have such fine limits that they are re-worked in a soundproof room for aural as well as visual checking of the diamond wheels used for reconditioning.

As with steel and cast iron, aluminium components pass to the machined parts store after manufacture. All components receive frequent alkaline washes during manufacture and immediately before leaving their departments but parts are passed through niagara washes again before entering the final assembly shop.

COMPLETE PACKAGE

Cleanliness is vital during final assembly and automatic transmissions are assembled in a pressurized shop to exclude dust (there is a similarly pressurized but smaller assembly shop in the converter department). The sub assembly and final assembly operations in this department are linked to a 166 ft conveyor system, with both powered and roller sections, on which the transmission is built up on moving cast aluminium pallets. Basically, this conveyor complex has one section for assembly and testing (the latter is on a bank of five dynamometers which simulate driving conditions) and a second for buttoning-up and air testing. The finished assembly is stored and transported on a special post pallet with a locating point for the transmission pan and folding posts for easy return carriage to the factory.

The automatic transmissions are then passed to the finished goods store. At this stage the Model 35 is a complete package of transmission and torque converter ready to be dropped into position on the assembly lines.

The importance of the quality control function is clear from the nature of some of the machining processes. This control is rigidly maintained especially on work for the hydraulic system, for no gaskets are used in it, the required seals being obtained by lapping the mating surfaces to a finish of 32 micro inches and a flatness of 0·0003 in. The hydraulic valves are case hardened steel with diameters ground to 0·0005 in tolerance and similar geometric limits. Their surface finish is held to 20 micro inches maximum.

A system of statistical quality control is being built up in the gauge room—which is well and expensively equipped—from constant investigations into gauge and machine performance. There are something like 3,000 gauges to be checked systematically on the production lines. Where accuracy and quantity are both so important the effectiveness of overall quality control is obviously crucial.

PRODUCTION CONTROL

Another crucial function is that of the production control department. With over 1,000 machine tools—many of them on extremely high precision work—and annealing, heat treatment, presswork, assembly and testing functions to be integrated in the overall production process, it is of prime economic importance that work-in-progress is at the right place at the right time. Plant must be fully utilized, product flow must be smooth and constant, production schedules must be scientifically programmed and controlled, and stores—raw materials, machined and bought-out parts, and finished goods—must be sufficient to meet production and customer demand yet not so great that capital is tied up unnecessarily.

The production control department is directly responsible for administering the goods inward procedure, the raw materials store, the machined parts store, the finished goods store and the dispatch department. It also controls production throughout the factory by the "line of balance" system, control points being set up at various points in the production process to check periodically that the correct balance of production is preserved. The department is responsible for issuing orders on the works and for making daily quantity issues from the raw materials store. Close and accurate control is essential yet the system has to be able to absorb any irregularities caused by rejects or by the unpredictable inflow of work to the reconditioning department. A system of compensating checks has been built into the system to handle situations of this kind.

Only ten days' stock is normally carried in the raw materials store and five days' in the finished parts store so that there is very little margin for error.

Thus, the new Borg-Warner factory is a challenging exercise in management and control demanding a combination of quality and quantity, of precision engineering and mass production. Like the product, the production methods have to be designed to precision limits.

Borg-Warner Limited, Letchworth, Hertfordshire.

Fig. 3 Final assembly on moving cast iron pallets. A sub-assembly test machine is in the background.

Packaged Auto

ALL the advantages of a yachting trip can be united with those of a motor tour if the car can be carried on the boat. Wherever the boat moors up, a three seater is ready to take the yatchsmen to local places of interest—because it is small enough to be stowed on board. It will also fit in the boot of a car.

The three seater three-wheeler is a product of the H. L. Diehl Co. of South Willington, Connecticut, USA, and has been named the Diehlmobile. It is said to be able to carry three adults at speeds up to 18 mph and to be able to traverse rough terrain and steep hills as well as made-up roads. As far as road worthiness is concerned, the Diehlmobile has been licensed to be driven in New York City, and the designer states that it will pass the inspection departments of all American states.

The original conception for the vehicle was as a land tender for yachts tied up at anchorages remote from supplies, to avoid a long trudge to and fro for provisions. It might also conceivably be used to ease the parking problem of very large cars—park the car outside the area and use the Diehlmobile for local transport in the restricted zone, folding it up for parking. Assembly and disassembly are a simple matter taking only some five minutes, and the only tool required (according to the makers) is a 50-cent piece. Presumably a half-crown or a penny would fill

the bill in other parts of the world. All parts are held together by either self-locking screws or aircraft-type fasteners.

The three illustrations show the transformation of the Diehlmobile from the boot to the road. The parts stow reasonably flat and are said to occupy the minimum of space. Assembly by the roadside is simple, the parts being packed in sequence. As can be seen the single front wheel is fitted first to the frame, and then the rear wheels added. The engine is a single assembly with one of the wheels. Figures for the weight of the vehicle are not quoted.

Power for the Diehlmobile is supplied by a 3 hp Briggs and Stratton engine fitted with marine type coil and wind-up starter. The ignition is locked by a key. The transmission is by Ratiometer belt drive, and speed control is by a single lever graduated for four speeds forward, neutral and one reverse. A foot operated brake is fitted and this has on it an adjustable clip for locking to hold the vehicle when parked. Maximum speed is 18 mph and the petrol consumption is small.

The frame is designed as a torsion structure and, coupled with the pneumatic tyres is said to produce a very smooth ride. The frame members are welded steel channels and have a rust protective baked finish. The wheel base is 54 in and the track 50 in. On the standard model the three wheels have 4·80/4·00 by 8 tyres (16 in diameter) while the *de luxe* version is fitted with super balloon tyres.

The single seat, which is wide enough to take three persons, has a frame of heavy gauge welded tubing, chromium plated. The seat itself is covered with tough vinyl-impregnated nylon, coloured royal blue. The frame is finished metallic grey and the wheels, fenders and front yoke red. The floor board is speckled neutral. The illustration of the completed vehicle shows the surrey top and supporting frame which are included in the *de luxe* model.

Steering of the Diehlmobile is by a tiller as can be seen in the same illustration and this is offset to the driver's side for more comfortable operation. In the *de luxe* version there is a horn mounted on the tiller bar. Apart from the

The three-seater Diehlmobile stows in the boot of a car as shown above. Assembly (left) takes a matter of moments, the only tool needed being a coin used as a screwdriver. Four speeds are available, the maximum being 18 mph. and the 3 hp engine has low petrol consumption.

surrey top and the balloon tyres already mentioned, the additions included in the *de luxe* model are an aluminium luggage compartment under the seat, a rear view mirror and a reflector.

The lighting system is battery operated and consists of a 4 in sealed beam headlight with bracket and fasteners; tail light assembly with illumination for number plate; rear light and stop light. The standard 12 volt battery as fitted will run for 8 hours between charges. The lighting system is additional to both models and there is a trickle charger available to keep the battery topped up.

All the additions which convert the standard model to the *de luxe* can be added later, and account for the difference in cost from $299·50 to $379·50. The lighting system adds another $51·50 to the total price. These prices as quoted refer to the local American market.

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